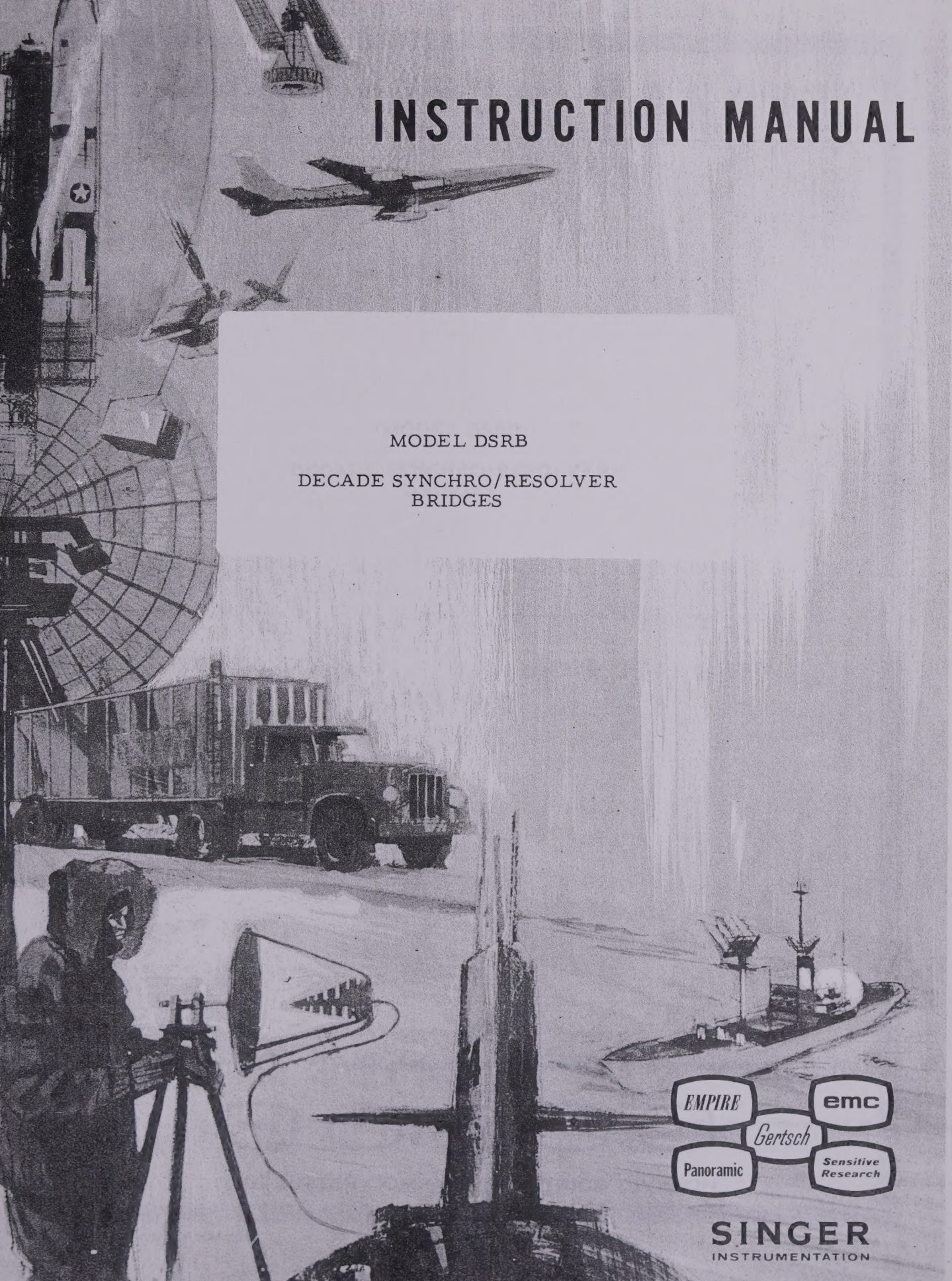




INSTRUCTION MANUAL

MODEL DSRB

DECADE SYNCHRO/RESOLVER
BRIDGES

EMPIRE

emc

Gertsch

Panoramic

Sensitive
Research

SINGER
INSTRUMENTATION

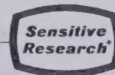
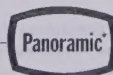
INSTRUCTION MANUAL

MODEL DSRB DECADE SYNCHRO/RESOLVER BRIDGES

REV 5/68

SINGER
INSTRUMENTATION

Precision electrical and electronic instruments for measurement



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- | | |
|--|--|
| 1. Model or Type | 5. Approximate date instrument was placed in operation |
| 2. Serial Number | 6. Approximate number of hours of use |
| 3. Description of trouble ⁽²⁾ | 7. Has maintenance action been previously requested? |
| 4. Test instruments used | 8. Other comments |

Upon receipt of this information our Service Department will send you service data or shipping instructions. Upon receipt of shipping instructions forward the instrument to the factory prepaid. If requested, an estimate of charges will be made before work begins.

(1) Contact Metrics Division, Bridgeport, Connecticut for *Empire**, *Panoramic**, and *Sensitive Research** instruments. Contact Metrics Division, Los Angeles, California for *Gertsch** instruments.

(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

TABLE OF CONTENTS

Section		Page
I	GENERAL DESCRIPTION	1-1
II	INSTALLATION	2-1/3-1
III	OPERATING INSTRUCTIONS	2-1/3-1
IV	THEORY OF OPERATION	4-1
V	MAINTENANCE	5-1
VI	CALIBRATION	6-1
VII	SCHEMATIC DIAGRAMS	7-1
VIII	PARTS LIST	8-1

LIST OF TABLES

Number		Page
1	General Specifications	1-3
2	Binding Post Identifications	2-1/3-1
3	Angular Accuracy, 5° Increments, Resolver Mode	6-7
4	Angular Accuracy, Synchro Mode	6-7
5	Angular Accuracy, Decade Increments, Resolver Mode	6-8
6	Angular Accuracy, Degrees, Minutes, Seconds	6-9

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Model DSRB Decade Synchro/Resolver Bridge	ii
1-2	Typical System-Error Measurement	1-1
1-3	Ratio Transformer Resolver Bridge	1-2
3-1	Test Binding Posts	2-1/3-1
4-1	Simplified Diagram, 10° Increments	4-2
4-2	Simplified Diagram, Decade Increments	4-3
4-3	Simplified Diagram, Decade Synchro Bridge	4-4
4-4	Standard Synchro Control Transmitter (CX) Outputs	4-4
6-1	Input Impedance Test Setup	6-1
6-2	Angular Accuracy Test Setup, Field Test, Resolver Mode	6-2
6-3	Angular Accuracy Test Setup, Field Test, Synchro Mode	6-3
6-4	Angular Accuracy Test Setup, Resolver Mode	6-5
6-5	Angular Accuracy Test Setup, Synchro Mode	6-6
7-1	Typical Schematic, .001° Resolution	7-1
7-2	Typical Schematic, .0001° Resolution	7-2
7-3	Typical Schematic, Degrees, Minutes, Seconds	7-3
7-4	Typical Schematic, Direct Readout	7-4

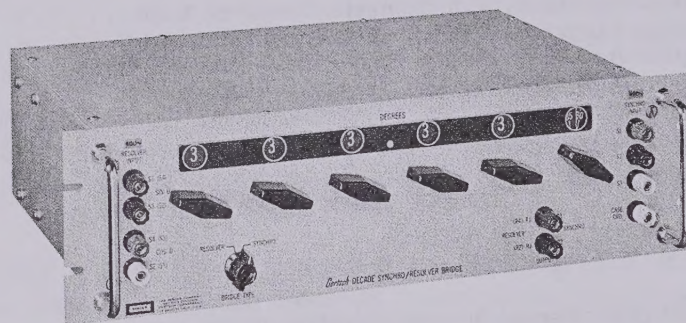


Figure 1-1. Model DSRB Decade Synchro/Resolver Bridge

SECTION I GENERAL DESCRIPTION

1-1. DESCRIPTION.

1-2. The Model DSRB combines the functions of a decade synchro bridge and a decade resolver bridge into a single unit. A front panel switch changes the unit from one mode of operation to the other. The units are designed for testing control transmitters, differentials (rotors), and torque transmitters as components or for simulating an incremental control transformer in a servo loop.

1-3. The increased versatility of these high resolution units provides additional applications as follows:

- a. As a distinctly superior system-error bridge, for measuring the output angle of synchros or resolvers which are an integral part of a system or sub-system; e.g., servos, radar antennas, inertial platforms, aircraft indicators, vertical and directional gyroscopes, etc. (See figure 1-2.)
- b. For trouble shooting sources of error in data transmission systems such as cable loading,

gearing, dial readout, component angular accuracy, receiver (Z_{SO}) impedance unbalance, transmitter (Z_{SS}) impedance unbalance, voltage and frequency deviations, etc.

- c. To simulate precision synchro or resolver transmitters, by using the decade bridge to calibrate an ordinary synchro or resolver transmitter at any desired angle. A vernier dial assembly, or a dividing head is required to null the transmitter, under load, against the bridge at each desired angle. This technique is ideal for simulating small errors in transmitters, generating accurately known system inputs to autopilots, servos, aircraft indicators, navigational computers, etc. This technique can also be used to check the response of a servo loop, and to investigate areas of particular interest very minutely. In multiple-speed systems a high-resolution transmitter is particularly useful.
- d. For measuring and recording the drift or stability of vertical or directional gyros, servos, inertial platforms, etc. When using the PAV in

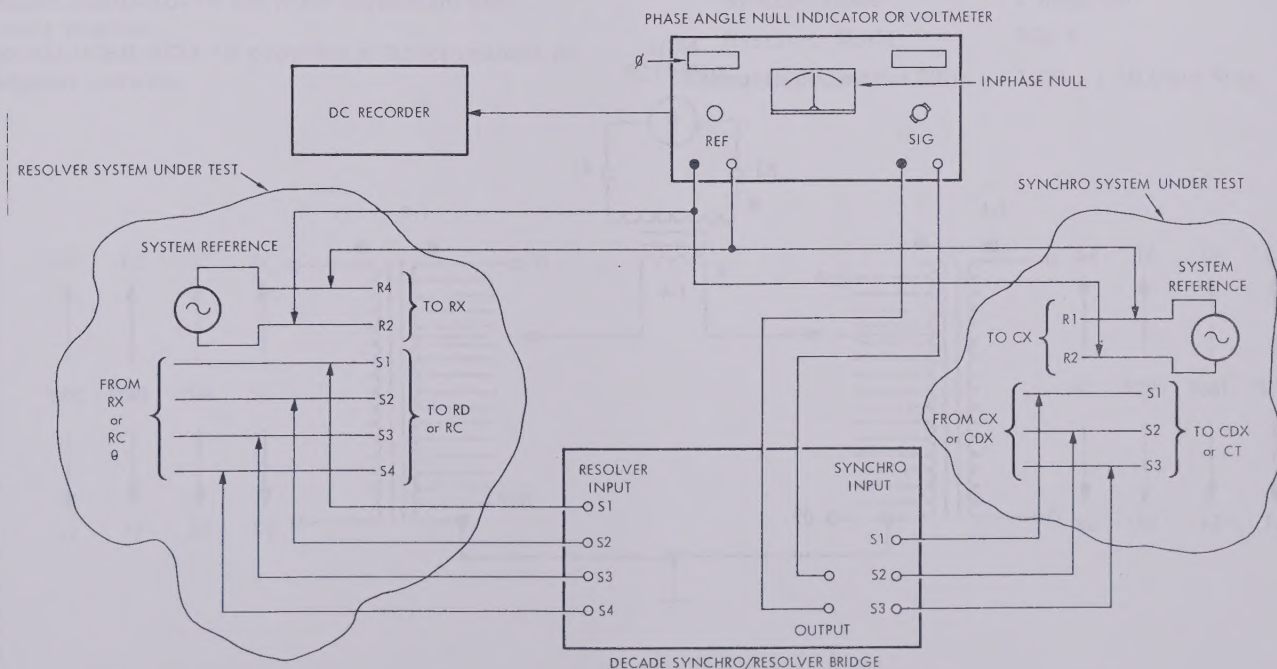


Figure 1-2. Typical System-Error Measurement

conjunction with the decade bridge, the angular drift or stability about any desired angular position may be read directly on the meter of the PAV, in terms of angular units. This error is also available in the form of a DC voltage, from the rear of the PAV for recording purposes.

- e. As a conventional 5° synchro or resolver bridge, to perform angular accuracy tests on transmitters and differentials (rotor). The unique feature here is that the bridge may be used to obtain a null, instead of the dividing head (Proportional Voltage Nulling Method).

1-4. GENERAL DESCRIPTION.

1-5. RESOLVER MODE. The decade resolver bridge uses precision transformers to form a voltage comparator bridge as shown in figure 1-3. The two voltage signals into the bridge bear a precise voltage ratio relationship which is determined by the angular position of the unit under test. The two signals are applied across Gertsch Ratiotrans* and movement of the ratio transformer arms is equivalent to change in the angular position of a control transformer. When the equivalent angular positions of the bridge and the input signals are identical, the output of the bridge (R1 and R3) is null (Zero volts).

1-6. When the equivalent angular positions of the bridge and the input signals differ, the bridge produces an error voltage. This error voltage is directly related to the angular difference but without compensation the error voltage is not constant throughout the 0° to 360° range. To provide an equal error voltage gradient

at all increments, all models of the bridge are inherently compensated. With compensation, the electrical error of a component under test may be determined without the necessity of obtaining an exact null at each increment (proportional voltage gradient method).

1-7. Two input isolation transformers provide complete isolation between the sine and cosine inputs and also reduce the secondary to primary reflected impedance. An isolation transformer is also included in the bridge output circuit.

1-8. The ratio accuracy, equivalent to 2 seconds-of-arc, is based upon the use of a toroidal transformer which is not affected by age or normal environmental conditions. Because of the low output impedance, the bridge is essentially insensitive to pickup and loading errors. The high input impedance allows an actual load to be connected in parallel with the bridge input, providing a test of the component under actual load conditions.

1-9. SYNCHRO MODE. In the synchro mode, the three wire input is converted to two voltage signals in a Scott-tee transformer arrangement. After conversion, the voltage comparator operates in the same manner as in the resolver mode.

1-10. MODELS COVERED.

1-11. All models of the bridge function in the same manner, however a variety of models has been designed to cover specific requirements. Refer to the General Specifications for a description of the major model differences.

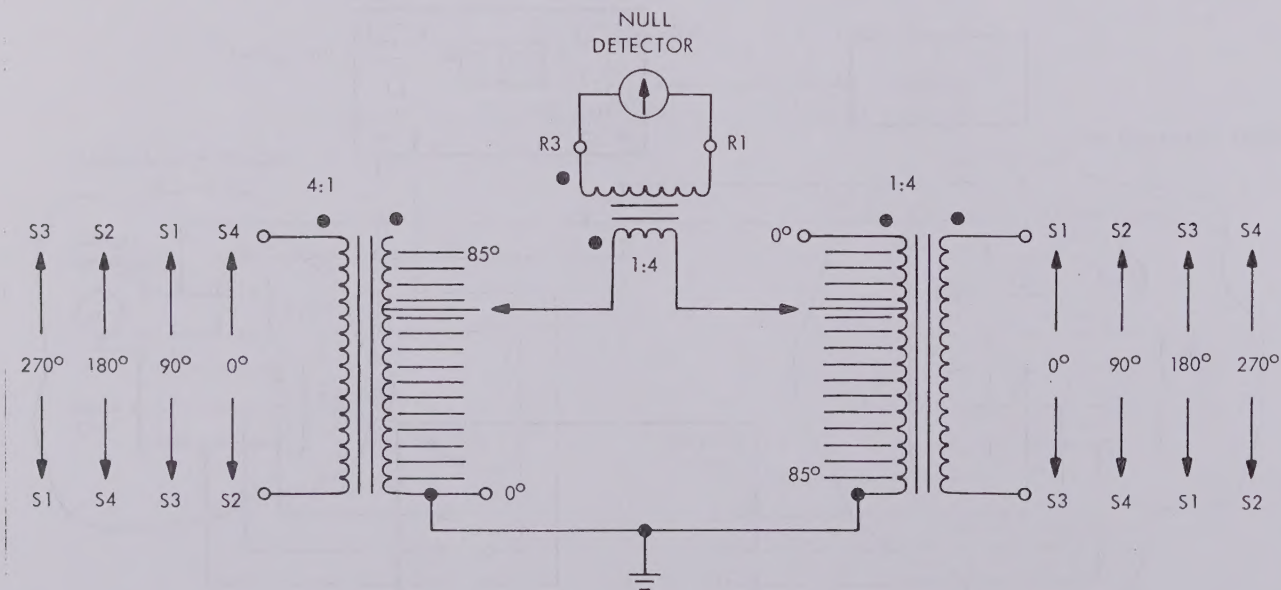


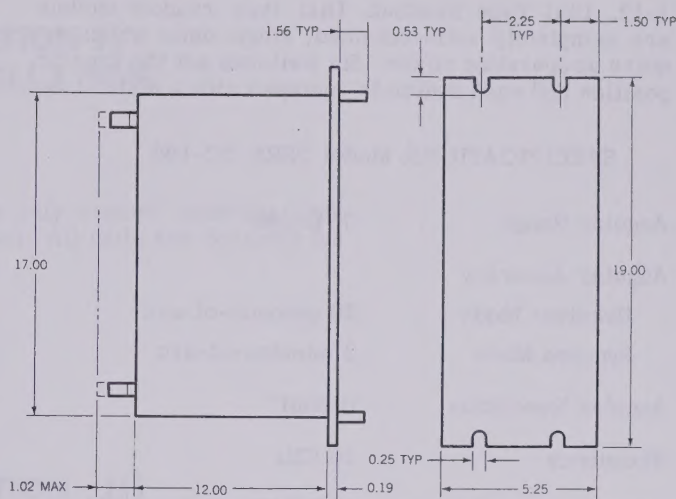
Figure 1-3. Ratio Transformer Resolver Bridge

*A trademark of the Singer Company.

TABLE 1. GENERAL SPECIFICATIONS

Angular Range	0° to 360°
Angular Accuracy	2 seconds-of-arc at nominal frequency
Angular Resolution	0.0001°
Nominal Frequency	
DSRB-5-4R	400 Hz
DSRB-5-8R	800 Hz
Frequency Range	± 1 octave from nominal
Maximum Input Voltage	0.35 F (F in Hz) or 170V
Error Voltage Gradient	4.85×10^{-6} Es (Max.) V/second ± 1%
Input Impedance at Nominal Frequency	
Synchro Mode	1 megohm
Resolver Mode	750 K
Figure of Merit	
Synchro Mode	100 $\angle 0^\circ$ (min)
Resolver Mode	75 $\angle 0^\circ$ (min)
Shipping Weight	25 lbs. (approx.)

Model DSRB-5C-*R provides a quadrant plus angle readout.
Model DSRB-5CD-*R provides a direct readout of angular position.



SPECIFICATIONS: Model DSRB-6CR

Accuracy at 60 Hz	
Synchro Mode	± 4 seconds-of-arc
Resolver Mode	± 2 seconds-of-arc
Error Voltage Gradient	$(4.85 \times 10^{-6} \times \text{Es (Max.)})$ V/second ± 1%
Frequency Range	50-70 Hz
Maximum Input Voltage	2.5 F (F in Hz) or 170V
Input Impedance at 60 Hz	
Synchro Mode	1 megohm
Resolver Mode	750 K
Output Impedance at 60Hz	1000 + j 60 Ohm Max.

1-12. Dial Type Readout. Dial type readout models are completely self-contained, single units which require no operating power. Six switches set the angular position and each switch is equipped with a dial.

SPECIFICATIONS: Model DSRB-5C-100

Angular Range	0° to 360°
Angular Accuracy	
Resolver Mode	20 seconds-of-arc
Synchro Mode	2 minutes-of-arc
Angular Resolution	0.0001°
Frequency	10 KHz
Maximum Input Voltage	0.05 F (F in Hz) or 170V
Input Impedance at 10KHz	50K
Shipping Weight	25 lbs. (approx.)

MODEL NO.	TYPE OF READOUT	ANGULAR INCREMENTS	NOMINAL FREQ.
DSRB-3C-4R	DIAL	.001°	400 Hz
DSRB-3C-8R	DIAL	.001°	800 Hz
DSRB-4CR	DIAL	.001°	60 Hz
DSRB-7C-4R	DIAL	Seconds	400 Hz
DSRB-7C-8R	DIAL	Seconds	800 Hz
DSRB-8CR	DIAL	Seconds	60 Hz

SECTION II INSTALLATION

2-1. GENERAL.

2-2. The decade models only require mounting since no input power is required. All units are designed for standard rack mounting.

SECTION III OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. Actual operation of the decade synchro/resolver bridges is simply a matter of connecting the input and output, turning the mode switch to the required position, and selecting the required angle. Precautions to be observed in setting up tests and operating the equipment are listed below. Suggested test setups and applications are given in Appendix III.

3-3. The color coding of the binding posts and the phase relations of the output voltage relative to input voltages conform to the requirements of Military Specification MIL-R-21530D (resolver mode) or to the requirements of Military Specification MIL-S-20708B (synchro mode). To convert the terminal identifications to the Aeronautical Radio, Inc. (ARINC) system, refer to table 2 (for the synchro mode). The conversions given in the table apply for 0 degree index reference and positive rotation reference.

TABLE 2. BINDING POST IDENTIFICATIONS

COLOR CODE	IDENTIFICATION	ARINC SYSTEM
Red	R1	H
Black	R2	C
Blue	S1	X
Black	S2	Z
Yellow	S3	Y
White	Case Gnd	

3-4. TEST BINDING POSTS.

3-5. The compensated models are furnished with four green binding posts and two shorting links. For operation as a standard unit, the two shorting links must

be installed as shown in figure 3-1. To operate the unit without the output isolation transformer, remove the shorting links and connect the output circuit to the "B" set of green binding posts. Connect R1 to the B post of the NO. 1 TEST set and connect R3 (or R2) to the B post of the NO. 2 TEST set.

3-6. SPECIAL PRECAUTIONS.

3-7. To obtain maximum accuracy, observe the following precaution:

- a. Avoid subjecting the bridge to large off-null signals if the output is shorted. If it is suspected that large off-null signals have been applied, check bridge calibration as outlined in Section VI.

3-8. To avoid damage to the equipment, observe the following precautions:

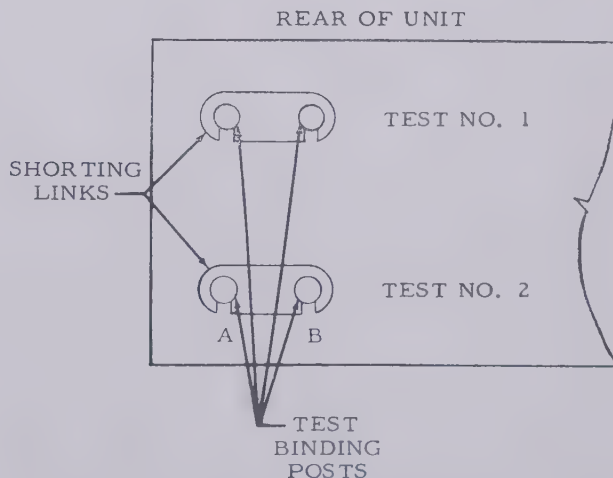


Figure 3-1. Test Binding Posts

- a. Make certain that the input voltage does not exceed the voltage rating of the unit. For 60 cps units, the voltage should not exceed 1.8 times the frequency in cps. For all other units, the voltage should not exceed 0.35 times the frequency in cps. The input voltage should never exceed 170 vrms.
- b. Make certain that the input voltage does not contain a dc component. DC currents of more than a few microamperes will cause saturation of

the input winding. If dc voltage is accidentally applied, degauss the unit as outlined in Section V.

- c. Do not apply voltage to the output terminals.

3-9. At true null, the error signal will be 180° out-of-phase (-) at a bridge angle greater than the null angle and in-phase (+) at a bridge angle less than the null angle. At false null (180° from true null), the phase relationships of the error signals are reversed. This applies only to the resolver mode; synchro mode is just the opposite.

SECTION IV THEORY OF OPERATION

4-1. GENERAL.

4-2. This section includes a general theory of operation for the resolver bridges. For a complete analysis, refer to Appendix I.

4-3. GENERAL THEORY, RESOLVER BRIDGE.

4-4. The electrical position of a resolver transmitter can be determined from the ratio of the two output voltages to each other. One of the output voltages is proportional to the sine of the rotational angle and the second output voltage is proportional to the cosine. At 0° , the sine output voltage approaches 0. At 45° , the two output voltages are equal and approach a 0.707 ratio to the input voltage.

4-5. In the Gertsch resolver bridge as shown in figure 4-1, the sine output voltage is applied across one ratio transformer and the cosine voltage is applied across a second. The ratio transformer with the sine voltage input is tapped to provide an output voltage proportional to the cosine. The second ratio transformer is tapped to provide an output voltage proportional to the sine.

4-6. With a resolver under test and the resolver bridge both set to 0° , both output voltages of the bridge approach 0 and a null detector would detect a null. The sine output voltage of the resolver under test approaches 0 and its ratio transformer is set to unity output. The cosine output voltage approaches a maximum but its ratio transformer is set to zero output. Thus both voltages approach zero.

4-7. For any angle between 0 and 90° , both voltage outputs of the bridge are proportional to a sine and a cosine product; therefore, the two voltages are equal. Any voltage detected across the output terminals indicates a different ratio between the output voltages of the resolver and therefore a different electrical angle.

4-8. DECADE INCREMENTS. (See figure 4-2.) When the incoming signal is not an exact 10° increment, the $\sin \theta \times \cos \theta_1$ product is larger than the $\cos \theta \times \sin \theta_1$ product. To compensate for this difference, decade transformers T3 through T5B, with their controlling switches, are included. The applicable switches select a precise portion of the input voltage and this selected portion is added to the $\cos \theta \times \sin \theta_1$ voltage supplied by transformer T2. At null, this summed voltage is exactly equal to the $\sin \theta \times \cos \theta_1$ voltage supplied by transformer T1.

4-9. The voltage supplied to the primary of transformer T3 is a sum of two voltages: a $\sin \theta \times \sin \theta_1$ voltage from transformer T1 and a $\cos \theta \times \cos \theta_1$

voltage from transformer T2. By trigonometric identities, this summed voltage may be expressed as $\cos (\theta - \theta_1)$. The voltage selected by the 1° switch is equal to $\cos (\theta - \theta_1) \tan \theta_2$.

4-10. Any voltage across transformer T6 may be expressed by the following formula:

$$1. \quad V = \sin \theta \cos \theta_1 - (\cos \theta \sin \theta_1 + \cos \theta - \theta_1) \tan \theta_2$$

$$2. \quad V = \sin \theta \cos \theta_1 - \cos \theta \sin \theta_1 - \cos (\theta - \theta_1) \tan \theta_2$$

$$3. \quad \sin \theta \cos \theta_1 - \cos \theta \sin \theta_1, \text{ by trigonometric identities, may be expressed as } \sin (\theta - \theta_1)$$

$$4. \quad V = \sin (\theta - \theta_1) - \cos (\theta - \theta_1) \tan \theta_2$$

$$5. \quad \tan \theta_2 = \frac{\sin \theta_2}{\cos \theta_2}. \text{ Multiply through to eliminate } \tan \theta_2.$$

$$6. \quad V \cos \theta_2 = \sin (\theta - \theta_1) \cos \theta_2 - \cos (\theta - \theta_1) \sin \theta_2$$

$$7. \quad \sin (\theta - \theta_1) \cos \theta_2 - \cos (\theta - \theta_1) \sin \theta_2, \text{ by trigonometric identities, may be expressed as } \sin (\theta - \theta_1 - \theta_2)$$

$$8. \quad V \cos \theta_2 + \sin (\theta - \theta_1 - \theta_2)$$

$$9. \quad V = \frac{\sin (\theta - \theta_1 - \theta_2)}{\cos \theta_2}$$

$$10. \quad \text{When the angular setting of the switches } (\theta_1, \theta_2, \text{ etc.}) \text{ exactly equals the incoming angle } \theta, \theta - \theta_1 - \theta_2 = 0.$$

$$11. \quad \text{The } \sin 0^\circ = 0 \text{ and therefore the voltage equals zero.}$$

4-11. Transformer T4 (see figure 7-1 or 7-2) receives its input from transformer T3 and is tapped to correspond to the $.1^\circ$ increments. The voltage selected by the $.1^\circ$ switch is added to the voltage on the 1° switch arm. This addition process continues through all the decades. A potentiometer provides continuous resolution and angular readout to the $.0001^\circ$ level.

4-12. QUADRANT SWITCHING. (See figure 7-1) The voltage ratios repeat every 90° , however for each of the quadrants the correct voltage ratios exist between a different set of resolver secondary voltages. The 90° switching network places the ratio transformers across the correct set of resolver outputs.

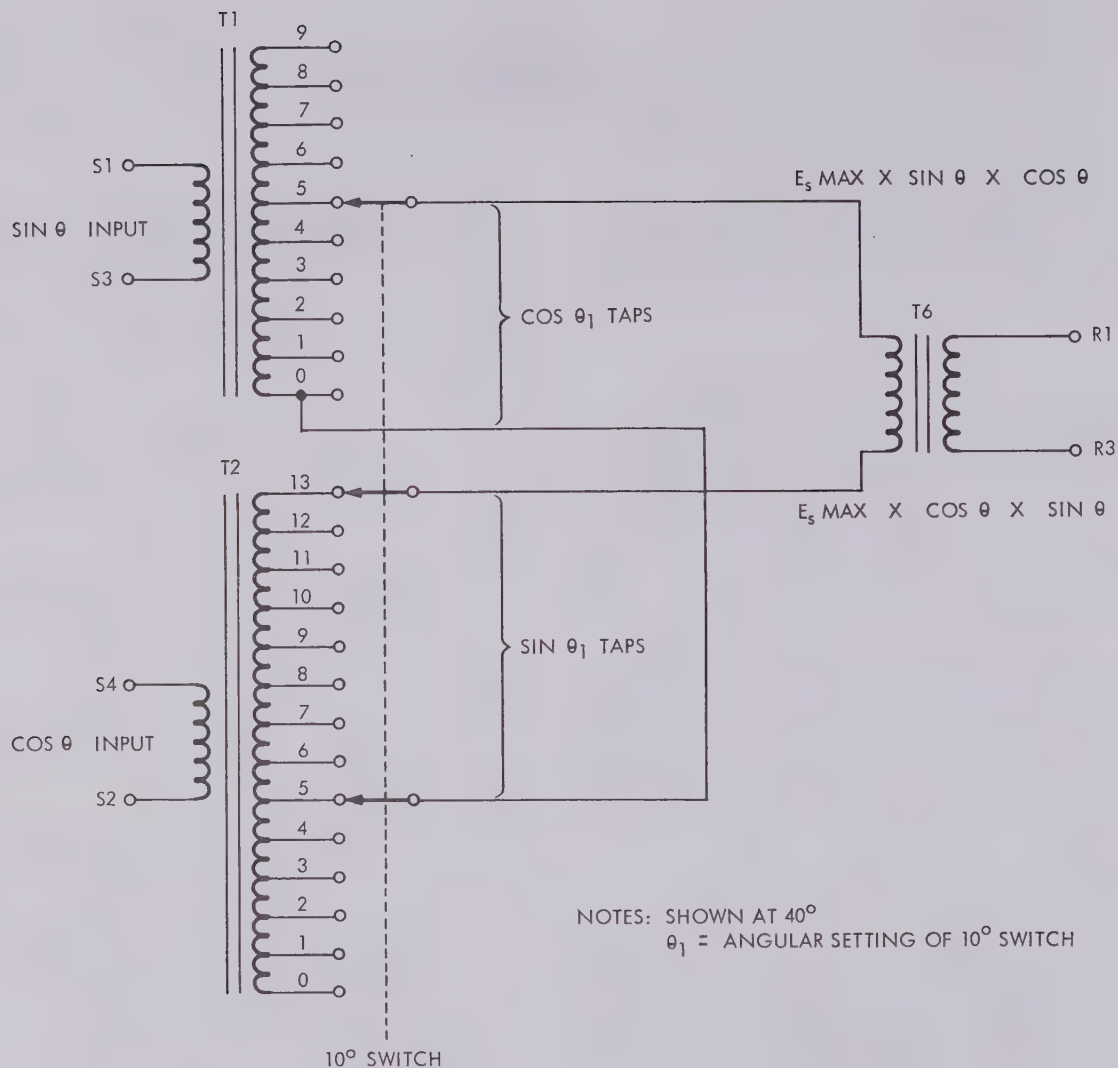


Figure 4-1. Simplified Diagram, 10° Increments

4-13. **DIRECT READOUT.** (See figure 7-4.) In the direct readout models, quadrant switching is accomplished through the 100° and 10° switches.

4-14. In the dial-type readout models, separate switches select the quadrants and each of the decades. Each switch is equipped with a dial. In the ADU readout models, the 90° and 10° switching networks are controlled by a single switch. Separate switch sections are used to apply voltages to the applicable members of the Nixie tubes in the ADU.

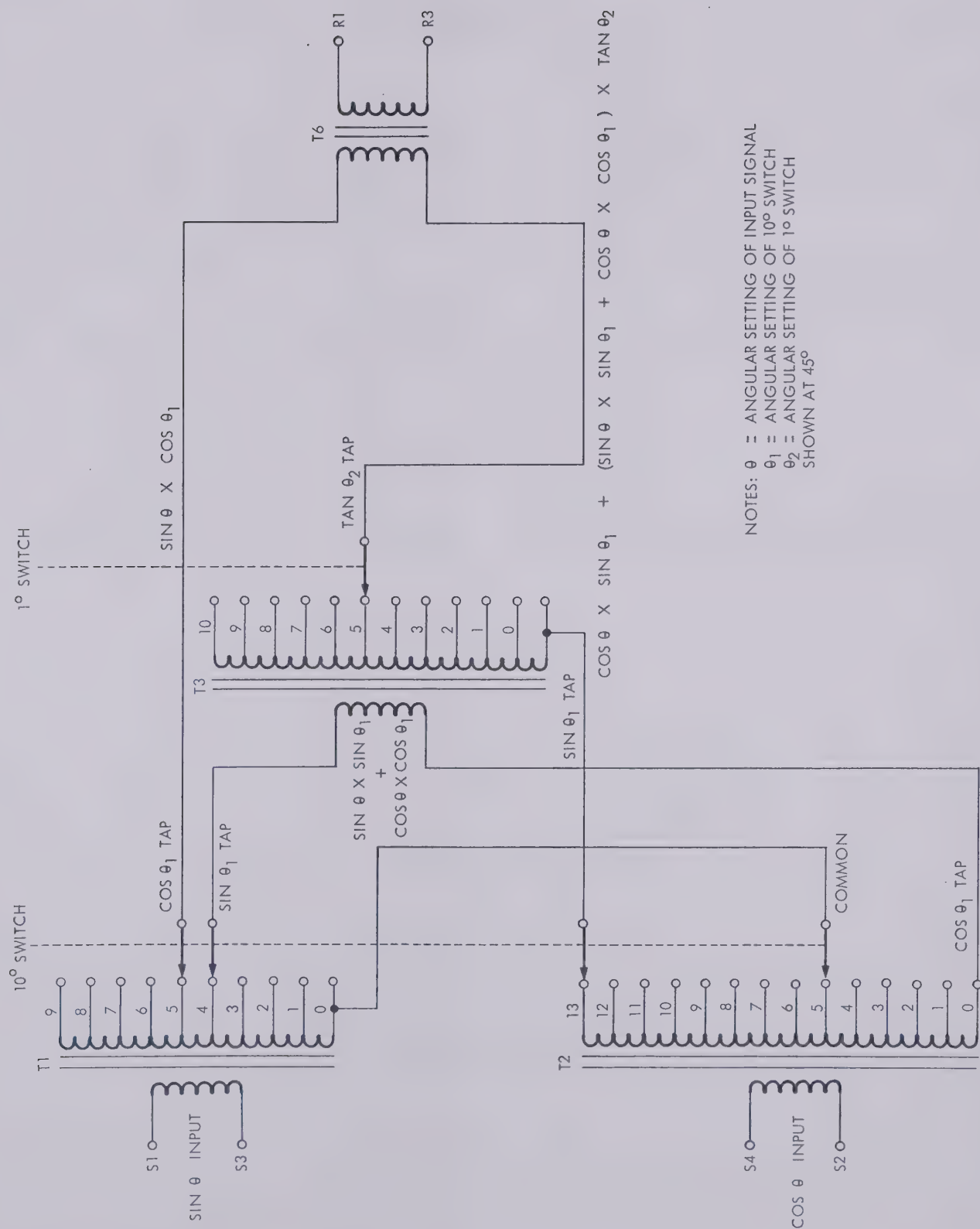
4-15. **SYNCHRO MODE.** (See figure 4-3.)

4-16. The electrical position of a synchro can be determined from the ratio of the stator output voltages to each other. As shown in figure 4-4, each of the three output voltages is a sine function.

4-17. In the 0° to 90° quadrant, the voltage from S1 to S3 is a SIN θ voltage and this is applied to the cosine ratio transformer. This ratio transformer operates the same as in the resolver mode with a SIN x COS output.

4-18. To derive a cosine input for the sine ratio transformer, the primaries of transformers T1 and T2 are interconnected as shown in figure 4-3. In this Scott-tee transformer arrangement, the voltage from the center tap of T1 to S2 is equal to COS 60° COS θ. This voltage is inserted at a COS 60° tap and therefore the voltage across the full transformer is equivalent to a COS θ input. This ratio transformer then operates the same as in the resolver mode with a COS x SIN output.

4-19. **DEGREES, MINUTES, SECONDS INCREMENTS.** For this readout, a different set of transformers is used but the units operate in the same manner.



NOTES: θ = ANGULAR SETTING OF INPUT SIGNAL
 θ_1 = ANGULAR SETTING OF 10° SWITCH
 θ_2 = ANGULAR SETTING OF 1° SWITCH
 SHOWN AT 45°

Figure 4-2. Simplified Diagram, Decade Increments

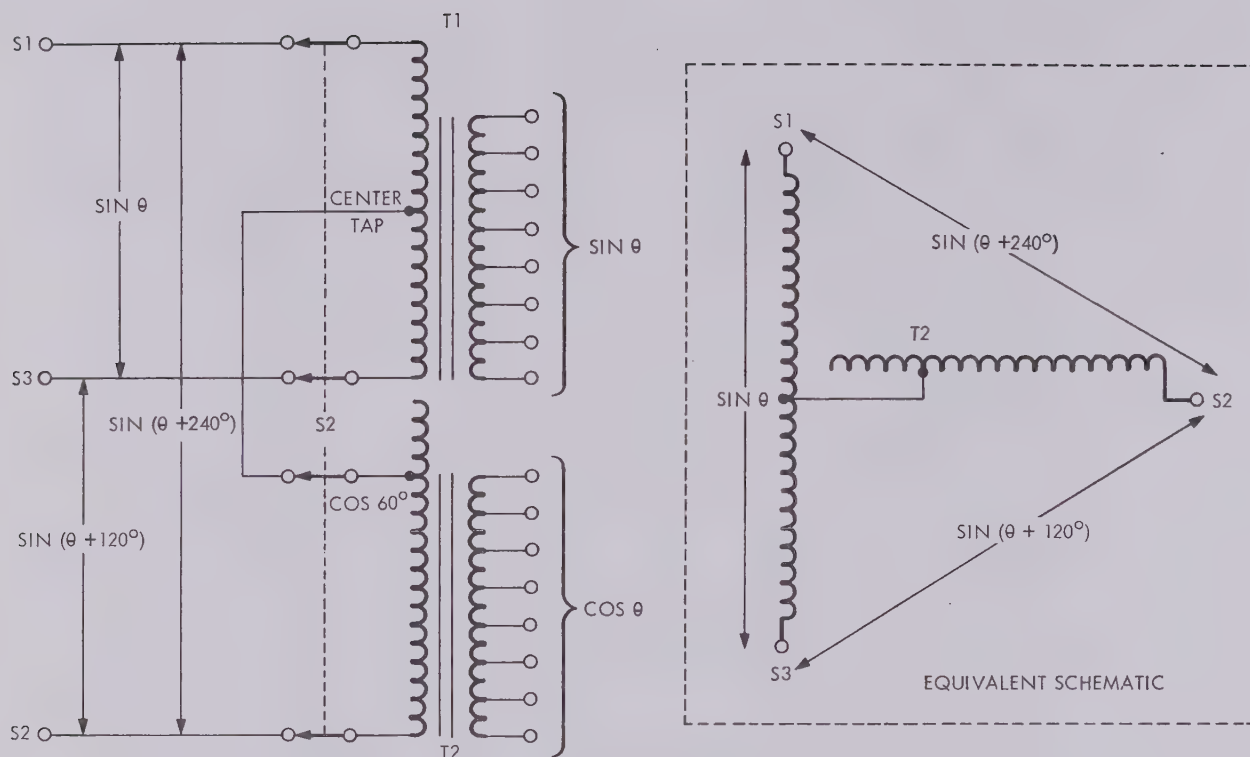


Figure 4-3. Simplified Diagram, Decade Synchro Bridge

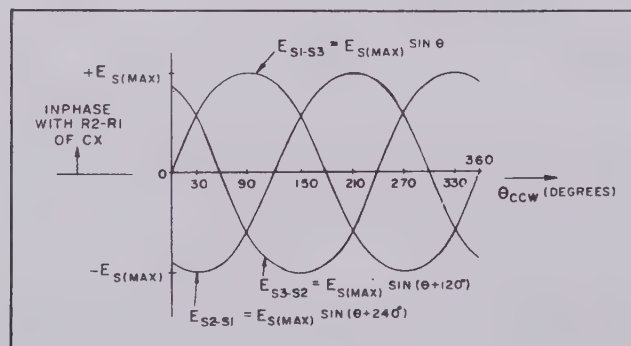


Figure 4-4. Standard Synchro Control Transmitter (CX) Outputs

SECTION V MAINTENANCE

5-1. GENERAL.

5-2. Since the bridges are passive devices, a minimum of maintenance is required. With the exception of cleaning switch contacts, no maintenance on a regularly scheduled basis is required. Moving parts are lubricated at the factory and should require no further lubrication.

5-3. SWITCH CONTACTS.

5-4. Once every three to six months, clean switch contacts with a good grade of solvent such as alcohol or acetone. Relubricate contacts with a layer of vaseline.

5-5. DEGAUSSING.

5-6. If dc voltage is accidentally applied to the input terminals, degauss the unit as follows:

- a. Turn mode switch to resolver.
- b. Connect a 1K resistor in series with input connector S1.

- c. By means of a variac or other suitable voltage control, apply a 60 cps signal between the open end of the 1K resistor and input terminal S3.

- d. Starting with the voltage control at zero, increase voltage to 40 vrms.

- e. Slowly decrease the voltage to zero. The period of time to reduce the voltage from 40 vrms to zero should be between 10 and 15 seconds.

- f. Repeat steps a through e with input terminals S2 and S4.

5-7. REPAIRS.

5-8. If any repairs are made on the unit or if any parts are replaced, check the accuracy of the unit as outlined in Section VI. If any transformer problems are encountered, it is recommended that the unit be returned to the factory for overhaul and recalibration.

SECTION VI CALIBRATION

6-1. GENERAL.

6-2. The 2 seconds-of-arc accuracy of the bridges should be maintained for a period of not less than three years, provided that the unit is kept in a normal laboratory environment, has clean low-resistance contacts, and does not suffer injury or insulation damage. Under these conditions, the unit should only require recalibration every three years. Under more severe conditions, the calibration period should be shortened.

6-3. This section includes two calibration checks:

- a. A 4 seconds-of-arc accuracy test which may be used for a rough field check. (See paragraphs 6-4 through 6-12.)
- b. A 2 seconds-of-arc accuracy test which may be used as a complete test of the unit. (See paragraphs 6-13 through 6-16.)

6-4. 4 SECONDS-OF-ARC TEST.

6-5. Input impedance test. To perform the input impedance test, the following test equipment (or equivalent) is required:

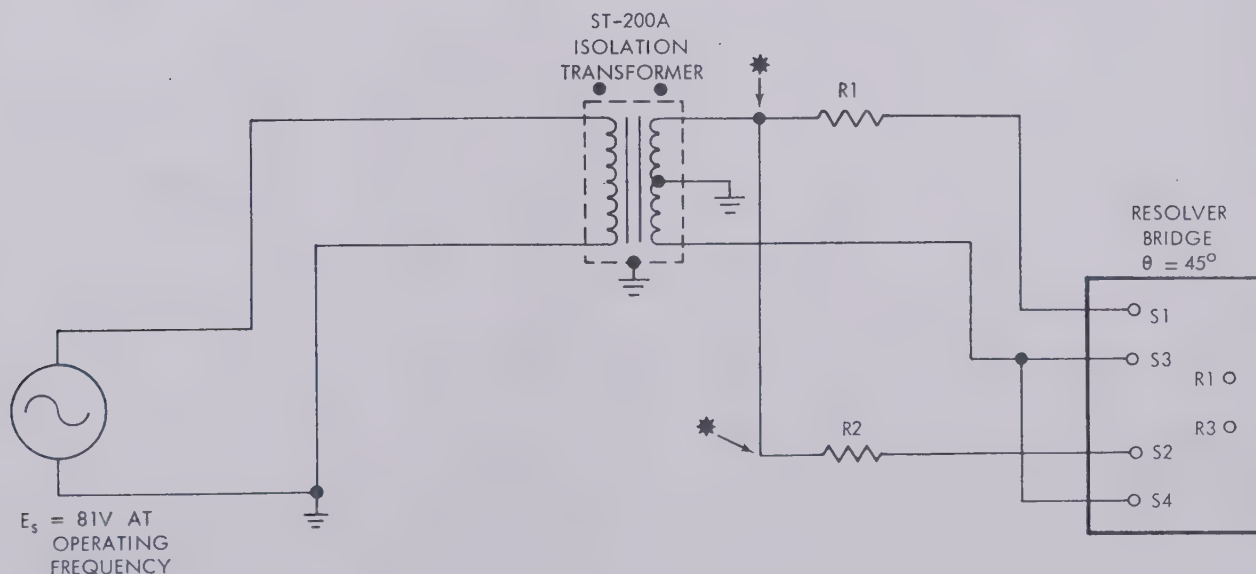
Isolation Transformer	Gertsch Model ST200A
Resistors (R1, R2)	50 ohms $\pm$ 1%
Voltmeter	Hewlett-Packard Model HP403A

6-6. TEST PROCEDURE.

- a. Connect resolver bridge in test setup as shown in figure 6-1.
- b. Turn mode switch to resolver.
- c. Adjust input voltage (E_s) to 81 volts at the normal operating frequency of the bridge.
- d. Set the bridge controls to a 45° angle.
- e. Measure voltage drop across resistors R1 and R2.
- f. The voltage drop shall be 0.008 volts or less (representing an input impedance of 500K or more).
- g. The input impedance in the synchro mode is theoretically equal to $1.5 \times$ the input impedance in the resolver mode.

6-7. ANGULAR ACCURACY TEST, RESOLVER MODE. To perform the angular accuracy test, the following test equipment (or equivalent) is required:

Resolver Standard	Gertsch Model RS (select standard to match frequency range)
Phase Angle Voltmeter	Gertsch Model PAV



* LOW (CASE) SIDE OF VOLTMETER INPUT

Figure 6-1. Input Impedance Test Setup

6-8. TEST PROCEDURE.

- Connect resolver bridge into test setup as shown in figure 6-2.
- Turn mode switch to resolver.
- Make certain the two shorting straps are installed across the test binding posts.
- Adjust phase angle voltmeter to measure in-phase voltage.
- Calculate the voltage output of the resolver bridge which is equivalent to a 4 seconds-of-arc error by the following formula:

$$V_{R1-R3} = 4.85 \times 10^{-6} \times E_S \times 4 \text{ (seconds-of-arc)}$$

Where E_S = maximum stator output voltage of resolver standard

EXAMPLE:

- $E_S = 90$ volts

$$V_{R1-R3} = 4.85 \times 10^{-6} \times 90 \times 4$$

$$V_{R1-R3} = 1.75 \text{ millivolts}$$

- $E_S = 11.8$ volts

$$V_{R1-R3} = 4.85 \times 10^{-6} \times 11.8 \times 4$$

$$V_{R1-R3} = .23 \text{ millivolts}$$

- $E_S = 115$ volts

$$V_{R1-R3} = 4.85 \times 10^{-6} \times 115 \times 4$$

$$V_{R1-R3} = 2.23 \text{ millivolts}$$

- The voltage output, as measured by the phase angle voltmeter shall not exceed the voltage calculated in step e.
- Repeat voltage check at each 5° step of the bridge with the standard set to the same angle.

6-9. VOLTAGE GRADIENT TEST. To perform the voltage gradient test, the same test equipment and test setup as used in the angular accuracy test are required.

6-10. TEST PROCEDURE.

- Connect resolver bridge into test setup as shown in figure 6-2.
- Turn mode switch to resolver.
- Adjust phase angle voltmeter to measure in-phase voltage.
- Adjust resolver standard to 5° .
- Adjust resolver bridge to 0° .
- Measure output voltage of the bridge.
- The error voltage shall be approximately 9% of E_S , maximum stator output voltage of the standard.

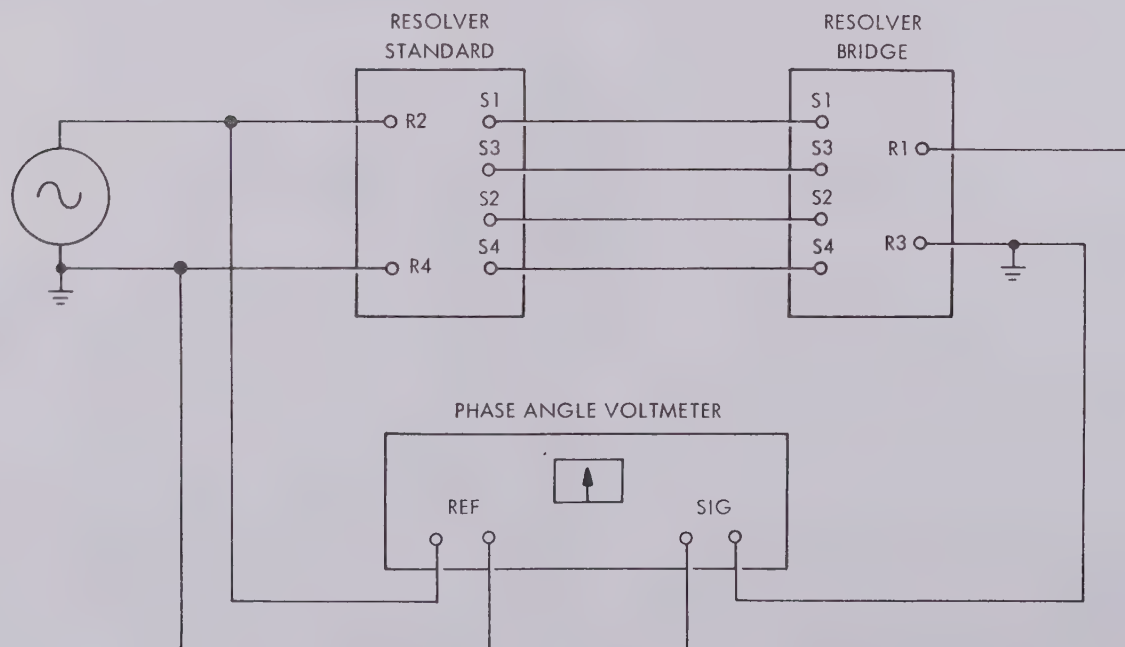


Figure 6-2. Angular Accuracy Test Setup, Field Test, Resolver Mode

- h. Repeat error voltage measurement at each 5° increment throughout the 0° to 90° range of the bridge. The standard shall be adjusted to maintain a constant 5° error at each increment.
- i. The error voltage shall be constant within ± 2% for each increment in the 0° to 90° range. (1% for the RS and 1% for the RB.)

6-11. ANGULAR ACCURACY TEST, SYNCHRO MODE. To perform the angular accuracy test, the following test equipment (or equivalent) is required:

Synchro Standard	Gertsch Model (select standard to match frequency range)
Phase Angle Voltmeter	Gertsch Model PAV

6-12. TEST PROCEDURE.

- a. Connect synchro bridge into test setup as shown in figure 6-3.
- b. Turn mode switch to synchro.
- c. Install shorting straps on the test binding posts.
- d. Adjust phase angle voltmeter to measure in-phase voltage.
- e. Calculate the voltage output of the synchro bridge which is equivalent, to 4 seconds-of-arc by the following formula:

$$V_{R1-R2} = 4.85 \times 10^{-6} \times E_S \times 4 \text{ (seconds-of-arc)}$$

where:

E_S = maximum stator output voltage of synchro standard

EXAMPLES:

1. $E_S = 90 \text{ volts}$

$$V_{R1-R2} = 4.85 \times 10^{-6} \times 90 \times 4$$

$$V_{R1-R2} = 1.75 \text{ millivolts}$$

2. $E_S = 11.8 \text{ V}$

$$V_{R1-R2} = 4.85 \times 10^{-6} \times 11.8 \times 4$$

$$V_{R1-R2} = .23 \text{ millivolts}$$

3. $E_S = 115 \text{ V}$

$$V_{R1-R2} = 4.85 \times 10^{-6} \times 115 \times 4$$

$$V_{R1-R2} = 2.23 \text{ millivolts}$$

- f. The voltage output, as measured by the phase angle voltmeter, shall not exceed the voltage calculated in step e.
- g. Repeat voltage check at 0°, 105°, 210°, and 330° with the synchro bridge and synchro standard set to the same angle.

6-13. 2 SECONDS-OF-ARC TEST.

6-14. INPUT IMPEDANCE TEST. Perform the input impedance test as outlined in paragraphs 6-5 and 6-6.

6-15. ANGULAR ACCURACY TEST, RESOLVER MODE. To perform the angular accuracy test, the following test equipment (or equivalent) is required:

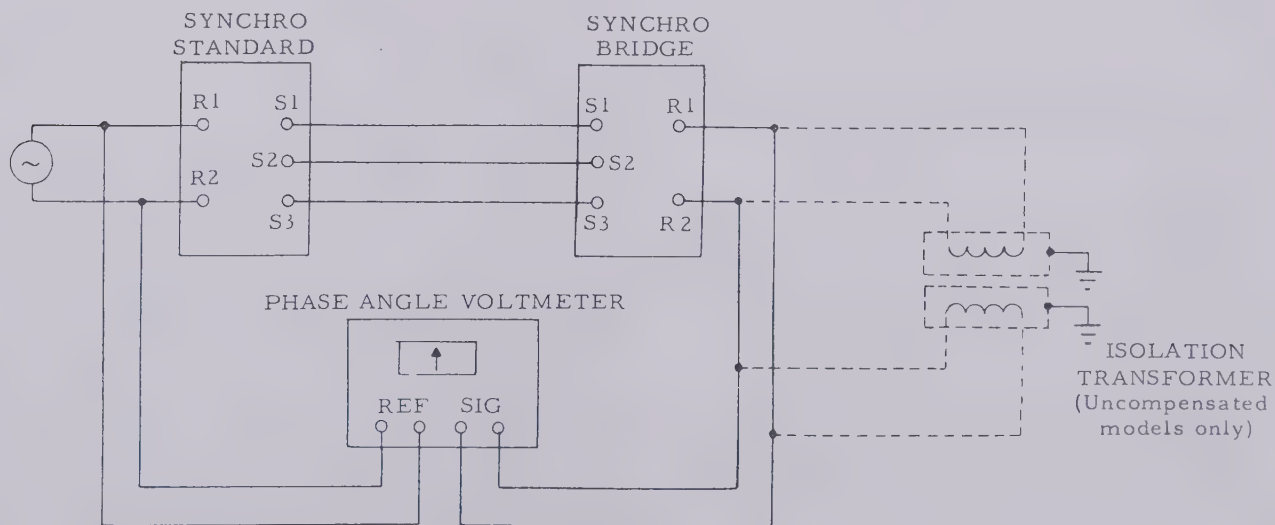


Figure 6-3. Angular Accuracy Test Setup, Field Test, Synchro Mode

AC Ratio Standard (T2, T3)	Gertsch Model 1011
Ratio Transformer (T1)	Gertsch Model RT-60
Phase Angle Voltmeter (V1, V2)	Gertsch Model PAV
Isolation Transformer (1)	Gertsch Model ST200
Isolation Transformer (2)	Gertsch Model ST200A (Matched to 2 ppm)
Switch (S1, S2, S3)	DPDT

6-16. TEST PROCEDURE.

- Connect resolver bridge into test setup as shown in figure 6-4.
- Turn mode switch to resolver.
- Make certain that the two shorting straps are installed across the test binding posts.
- Adjust resolver bridge to 0°.
- Adjust phase angle voltmeters V1 and V2 to measure in-phase voltage.
- Set switch S1 to the No. 2 position.
- Set switches S2 and S3 to the No. 1 position.
- Set Ratio Transformer T1 to a ratio of 1.00.
- Adjust AC Ratio Standard T2 as required to obtain a null on phase angle voltmeter V2. The approximate ratio at which a null will be obtained is given in the theoretical ratio column of table 3.
- Adjust AC Ratio Standard T3 as required to obtain a null on phase angle voltmeter V1.
- AC Ratio Standard T3 shall indicate the theoretical ratio given in table 3 within the limits set by the maximum deviation column.
- Repeat test at each 5° increment of the bridge. Set Ratio Transformer T1 to the values specified in table 3. Operate switches S1, S2, and S3 as noted in figure 6-4. Refer to table 3 for the theoretical ratio settings of AC Ratio Standard T3 and maximum allowable deviations.
- Repeat test at each increment listed in table 4. Set Ratio Transformer T1 to the values specified in table 4. Refer to table 4 for the theoretical ratio settings of AC Ratio Standard T3 and maximum allowable deviations.

6-17. VOLTAGE GRADIENT TEST. The same test equipment and setup used in the angular accuracy test are required.

6-18. TEST PROCEDURE.

- Adjust bridge and test equipment as outlined in steps a through i of paragraph 6-16.
- Advance resolver bridge to 5°.
- The error voltage measured by phase angle voltmeter V2 shall be approximately 9% of E_s (10.4 volts).
- Repeat error voltage measurement at each 5° increment throughout the 0° to 90° range.
- The error voltage shall be constant within $\pm 1\%$ for each increment in the 0° to 90° range.

6-19. ANGULAR ACCURACY TEST, SYNCHRO MODE. To perform the angular accuracy test, the following test equipment (or equivalent) is required:

AC Ratio Standard (T2, T3)	Gertsch Model 1011
Ratio Transformer (T1)	Gertsch Model RT-60
Isolation Transformer (T4)	Gertsch Model ST200A
Isolation Transformer (T5)	Gertsch Model ST103 (not required if a Model PAV-2 or PAV-3 phase angle voltmeter is used)
Switch (S1)	DPDT
Switch (S2)	3 pole, 3 position
Phase Angle Voltmeter (V1, V2)	Gertsch Model PAV

6-20. TEST PROCEDURE.

- Connect synchro bridge into test setup as shown in figure 6-5.
- Turn mode switch to synchro.
- Install shorting straps on the test binding posts.
- Adjust synchro bridge to 0°.
- Adjust phase angle voltmeter V1 and V2 to measure in-phase voltage.
- Set switches S1 and S2 to the No. 1 position.
- Set Ratio Transformer T1 to a ratio of 0.87.
- Adjust AC Ratio Standard T2 as required to obtain a null on phase angle voltmeter V1. The approximate ratio at which a null will be obtained is given in the theoretical ratio column of table 5.

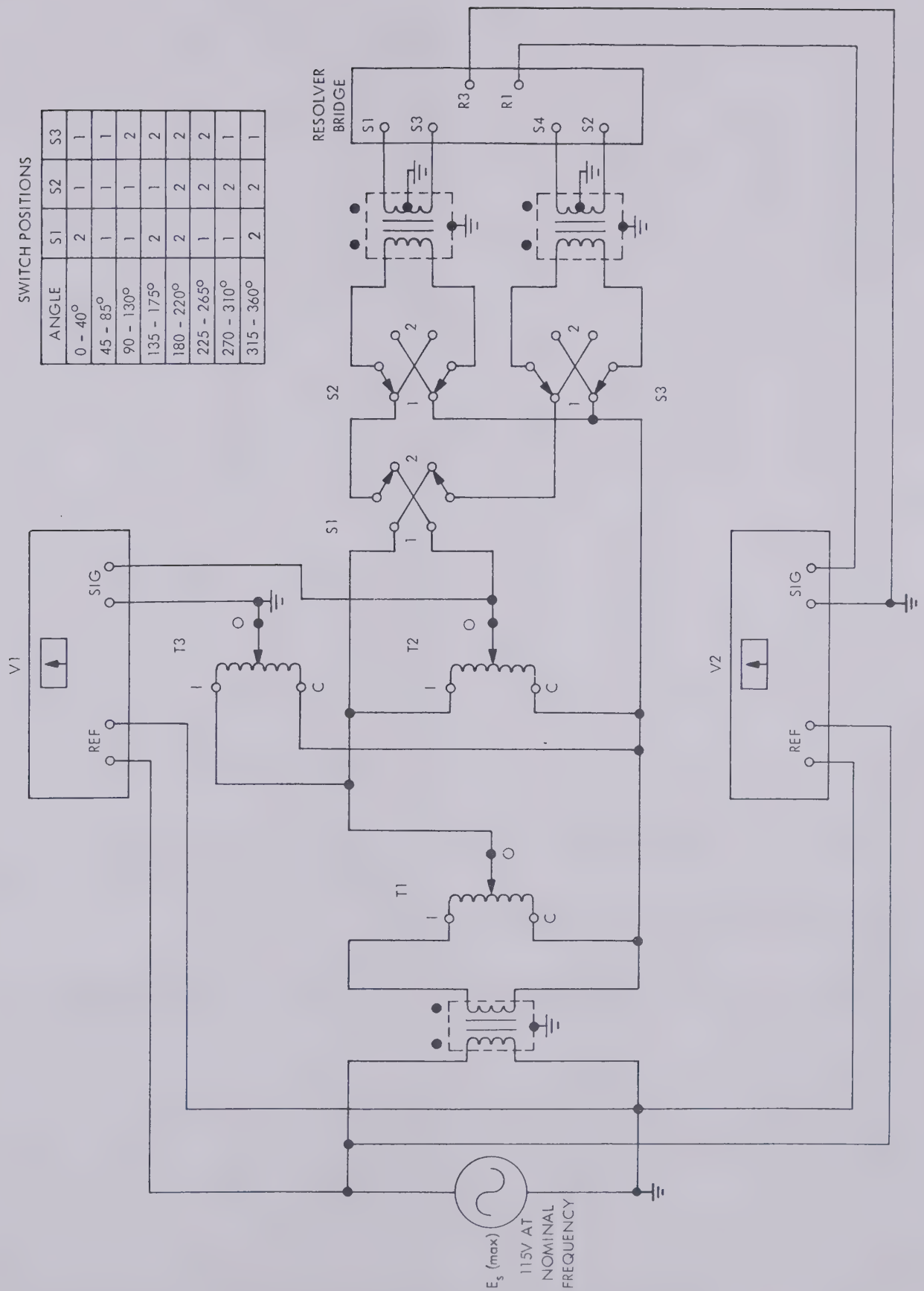


Figure 6-4. Angular Accuracy Test Setup, Resolver Mode

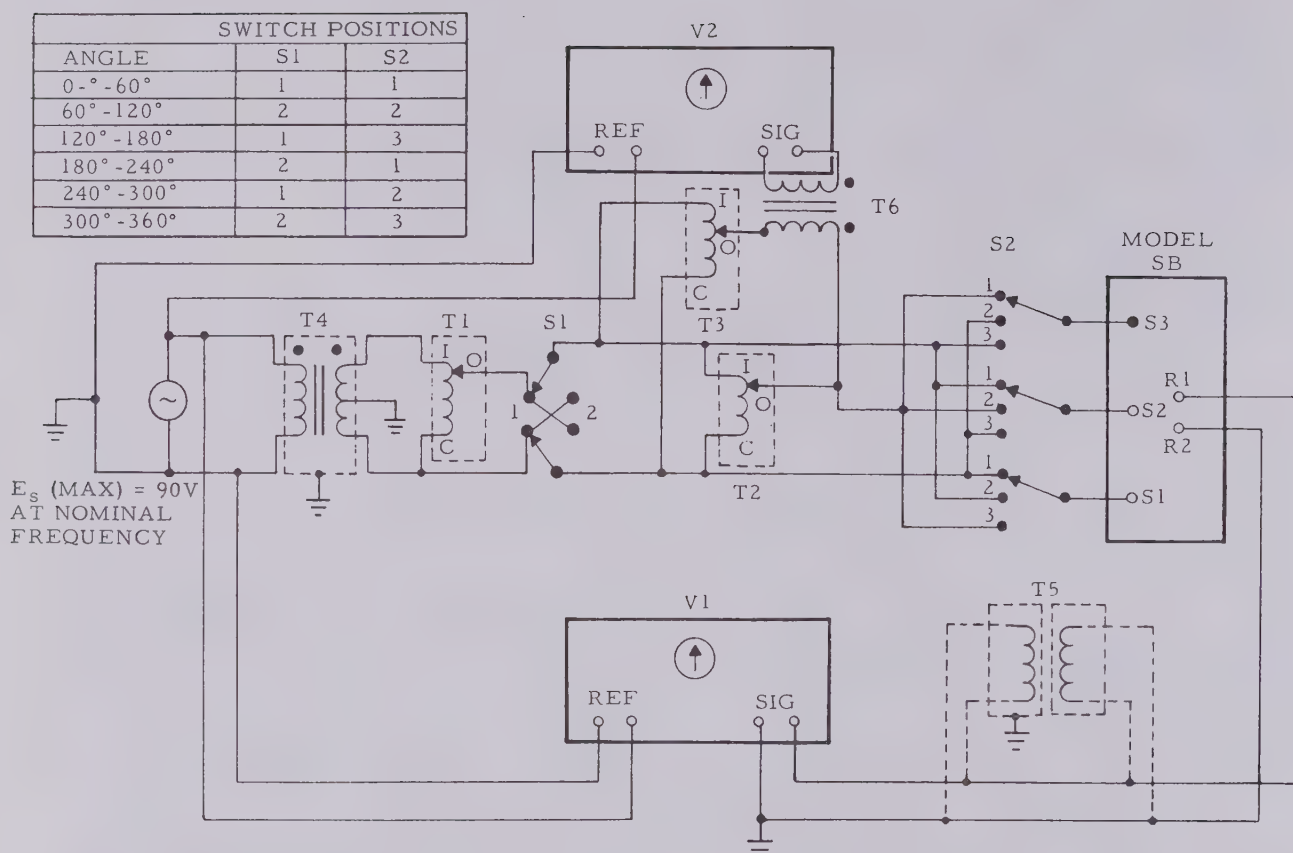


Figure 6-5. Angular Accuracy Test Setup, Synchro Mode

- i. Adjust AC Ratio Standard T3 as required to obtain a null on phase angle voltmeter V2.
- j. AC Ratio Standard T3 shall indicate the theoretical ratio given in table 5 within the limits set by the maximum deviation column.
- k. Repeat test at each angle given in table 5. Set Ratio Transformer T1 to the values specified in

table 4. Operate switches S1 and S2 as noted in figure 6-5. Refer to table 5 for theoretical ratio settings of AC Ratio Standard T3 and maximum allowable deviation.

NOTE

Use table 6 for units with a readout in degrees, minutes, and seconds.

TABLE 3. ANGULAR ACCURACY, 5° INCREMENTS, RESOLVER MODE

RESOLVER BRIDGE ANGULAR SETTING				T1	THEORETICAL RATIO	MAXIMUM DEVIATION (±)
0	90	180	270	1.00	0.0000000	.0000097
5	95	185	275	1.00	0.0874887	.0000098
10	100	190	280	.98	0.1763270	.0000100
15	105	195	285	.97	0.2679492	.0000104
20	110	200	290	.94	0.3639702	.0000110
25	115	205	295	.91	0.4663077	.0000118
30	120	210	300	.87	0.5773503	.0000130
35	125	215	305	.82	0.7002075	.0000145
40	130	220	310	.77	0.8390996	.0000165
45	135	225	315	.71	1.0000000	.0000194
50	140	230	320	.77	0.8390996	.0000165
55	145	235	325	.82	0.7002075	.0000145
60	150	240	330	.87	0.5773503	.0000130
65	155	245	335	.91	0.4663077	.0000118
70	160	250	340	.84	0.3639702	.0000110
75	165	255	345	.97	0.2679492	.0000104
80	170	260	350	.98	0.1763270	.0000100
85	175	265	355	1.00	0.0874887	.0000098

TABLE 4. ANGULAR ACCURACY, SYNCHRO MODE

SYNCHRO BRIDGE ANGULAR SETTING	T1	THEORETICAL RATIO	MAXIMUM DEVIATION (±)
0	.87	0.0000000	.0000112
135	.97	0.2679492	.0000090
210	1.00	0.5000000	.0000084
345	.97	0.7320508	.0000090

TABLE 5. ANGULAR ACCURACY, DECADE INCREMENTS, RESOLVER MODE

ANGULAR SETTING	T1	THEORETICAL RATIO (TAN θ)	MAXIMUM DEVIATION ($\pm$)
.001	1.00	.0000175	.0000097
.002	1.00	.0000349	.0000097
.003	1.00	.0000524	.0000097
.004	1.00	.0000698	.0000097
.005	1.00	.0000873	.0000097
.006	1.00	.0001047	.0000097
.007	1.00	.0001222	.0000097
.008	1.00	.0001396	.0000097
.009	1.00	.0001571	.0000097
.01	1.00	.0001745	.0000097
.02	1.00	.0003491	.0000097
.03	1.00	.0005236	.0000097
.04	1.00	.0006981	.0000097
.05	1.00	.0008727	.0000097
.06	1.00	.0010472	.0000097
.07	1.00	.0012217	.0000097
.08	1.00	.0013963	.0000097
.09	1.00	.0015708	.0000097

ANGULAR SETTING	T1	THEORETICAL RATIO (TAN θ)	MAXIMUM DEVIATION ($\pm$)
.1	1.00	.0017453	.0000097
.2	1.00	.0034907	.0000097
.3	1.00	.0052360	.0000097
.4	1.00	.0069814	.0000097
.5	1.00	.0087269	.0000097
.6	1.00	.0104724	.0000097
.7	1.00	.0122179	.0000097
.8	1.00	.0139635	.0000097
.9	1.00	.0157093	.0000097
1	1.00	.0174551	.0000097
2	1.00	.0349208	.0000097
3	1.00	.0524078	.0000097
4	1.00	.0699268	.0000098
5	1.00	.0874887	.0000098
6	1.00	.1051042	.0000098
7	.99	.1227846	.0000098
8	.99	.1405408	.0000100
9	.98	.1583844	.0000100

TABLE 6 ANGULAR ACCURACY, DEGREES, MINUTES, SECONDS INCREMENTS

ANGULAR SETTING θ	T1	THEORETICAL RATIO (TAN θ)	MAXIMUM DEVIATION
1"	1.00	0000049	.0000097
2"	1.00	0000097	.0000097
3"	1.00	0000145	.0000097
4"	1.00	0000194	.0000097
5"	1.00	0000242	.0000097
6"	1.00	0000291	.0000097
7"	1.00	0000339	.0000097
8"	1.00	0000388	.0000097
9"	1.00	0000436	.0000097
10"	1.00	0000485	.0000097
20"	1.00	0000970	.0000097
30"	1.00	0001454	.0000097
40"	1.00	0001939	.0000097
50'	1.00	0002424	.0000097
1'	1.00	0002909	.0000097
2'	1.00	0005818	.0000097
3'	1.00	0008727	.0000097
4'	1.00	0011636	.0000097
5'	1.00	0014545	.0000097
6'	1.00	0017453	.0000097
7'	1.00	0020362	.0000097
8'	1.00	0023271	.0000097
9'	1.00	0026180	.0000097
10'	1.00	0029089	.0000097
20'	1.00	0058178	.0000097
30'	1.00	0087269	.0000097
40'	1.00	0116361	.0000097
50'	1.00	0145454	.0000097
1°	1.00	0174551	.0000097
2°	1.00	0349208	.0000097
3°	1.00	0524078	.0000097
4°	1.00	0699268	.0000097
5°	1.00	0874887	.0000098
6°	1.00	1051042	.0000098
7°	.99	1227846	.0000098
8°	.99	1405408	.0000100
9°	.98	1583844	.0000100
10°	.98	1763270	.0000100

SECTION VII SCHEMATIC DIAGRAMS

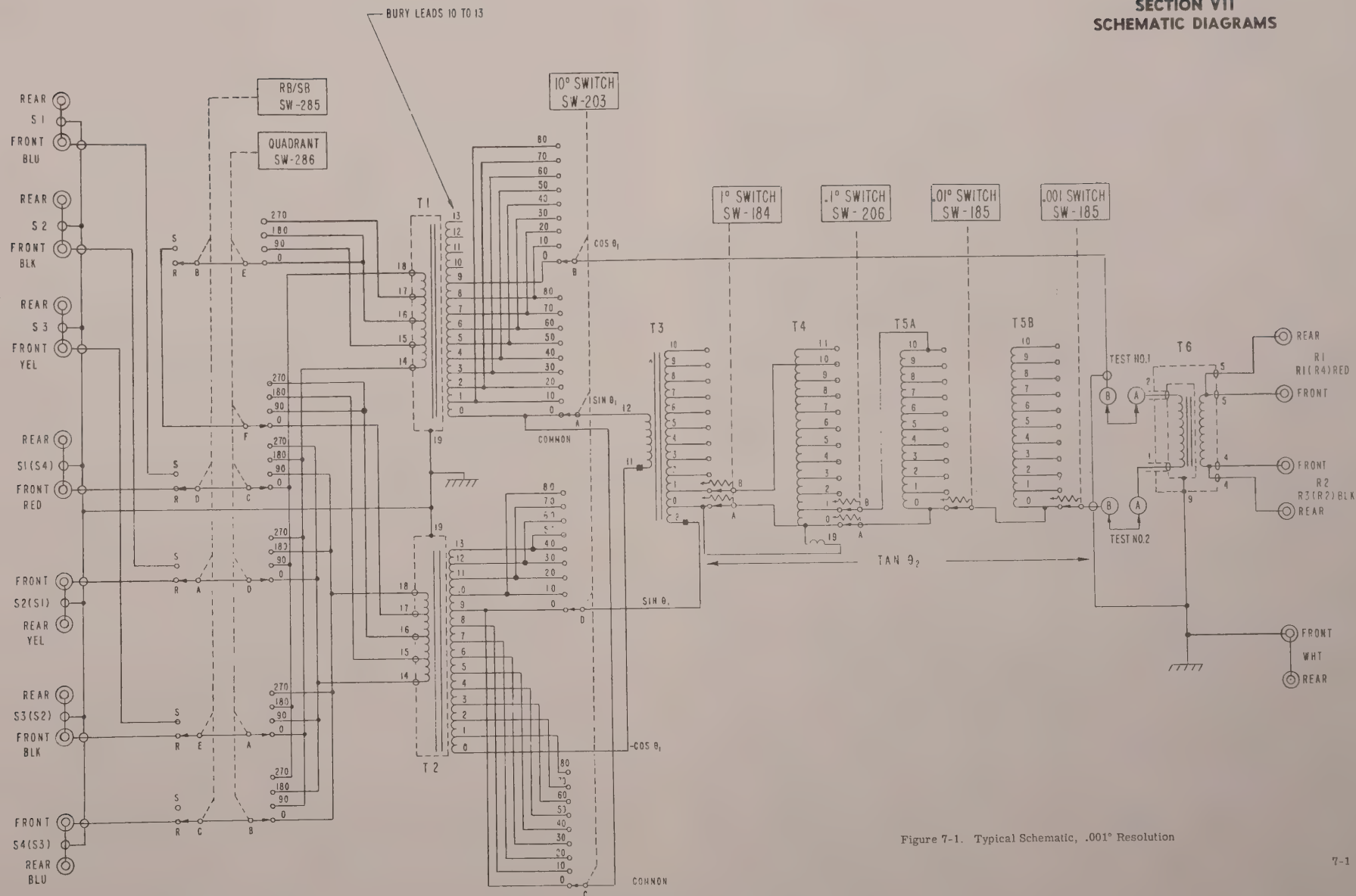


Figure 7-1. Typical Schematic, .001° Resolution

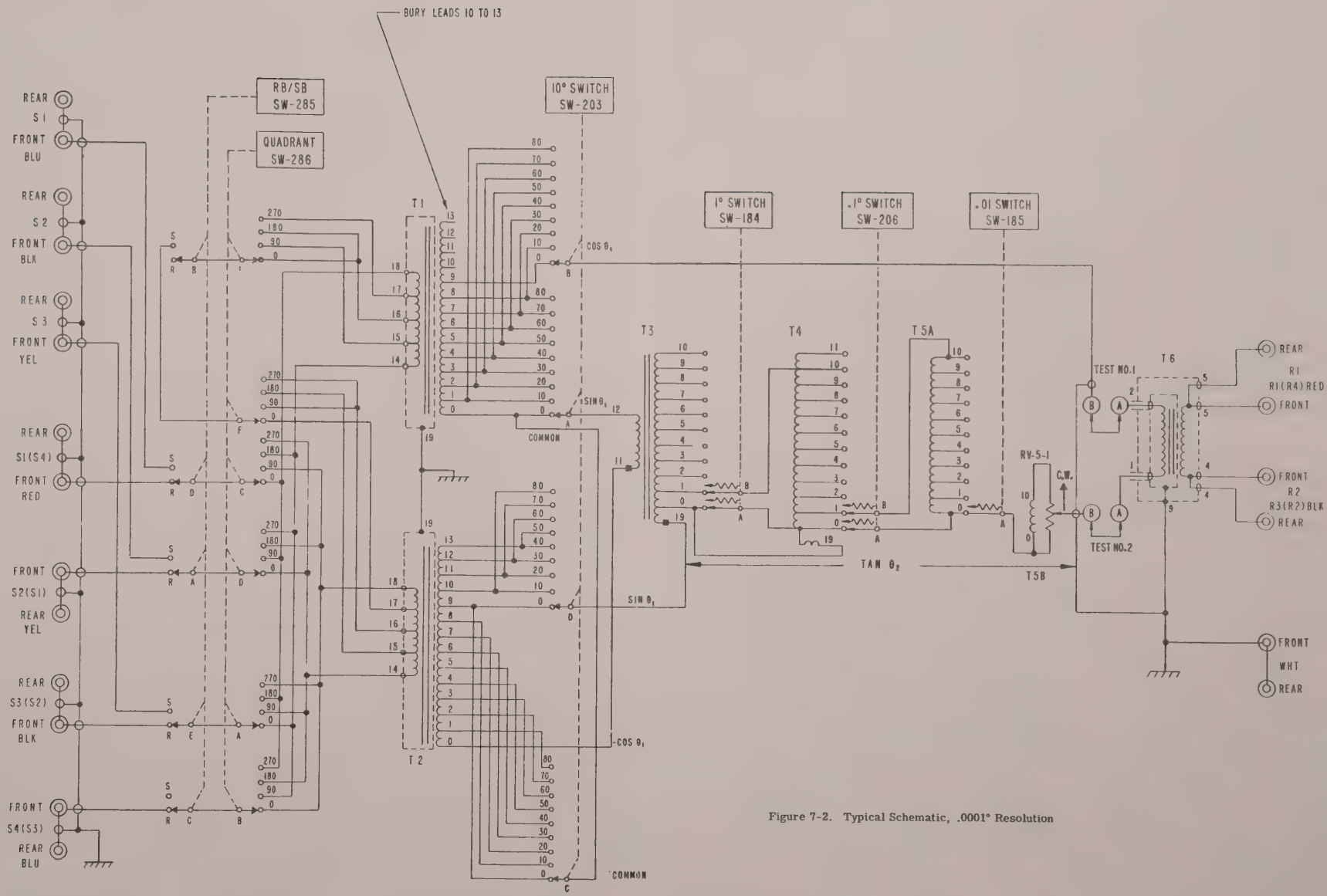


Figure 7-2. Typical Schematic, .0001° Resolution

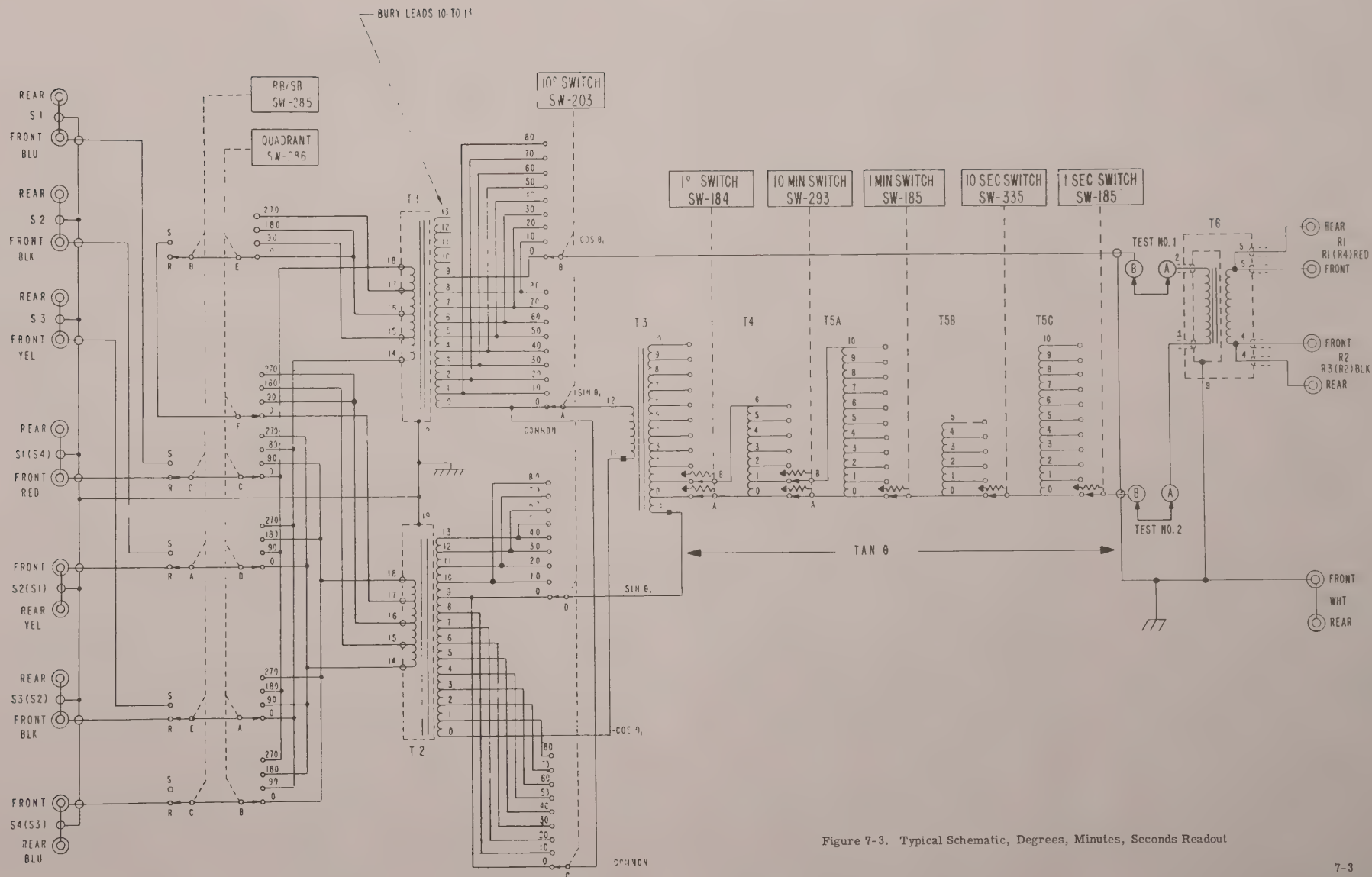


Figure 7-3. Typical Schematic, Degrees, Minutes, Seconds Readout

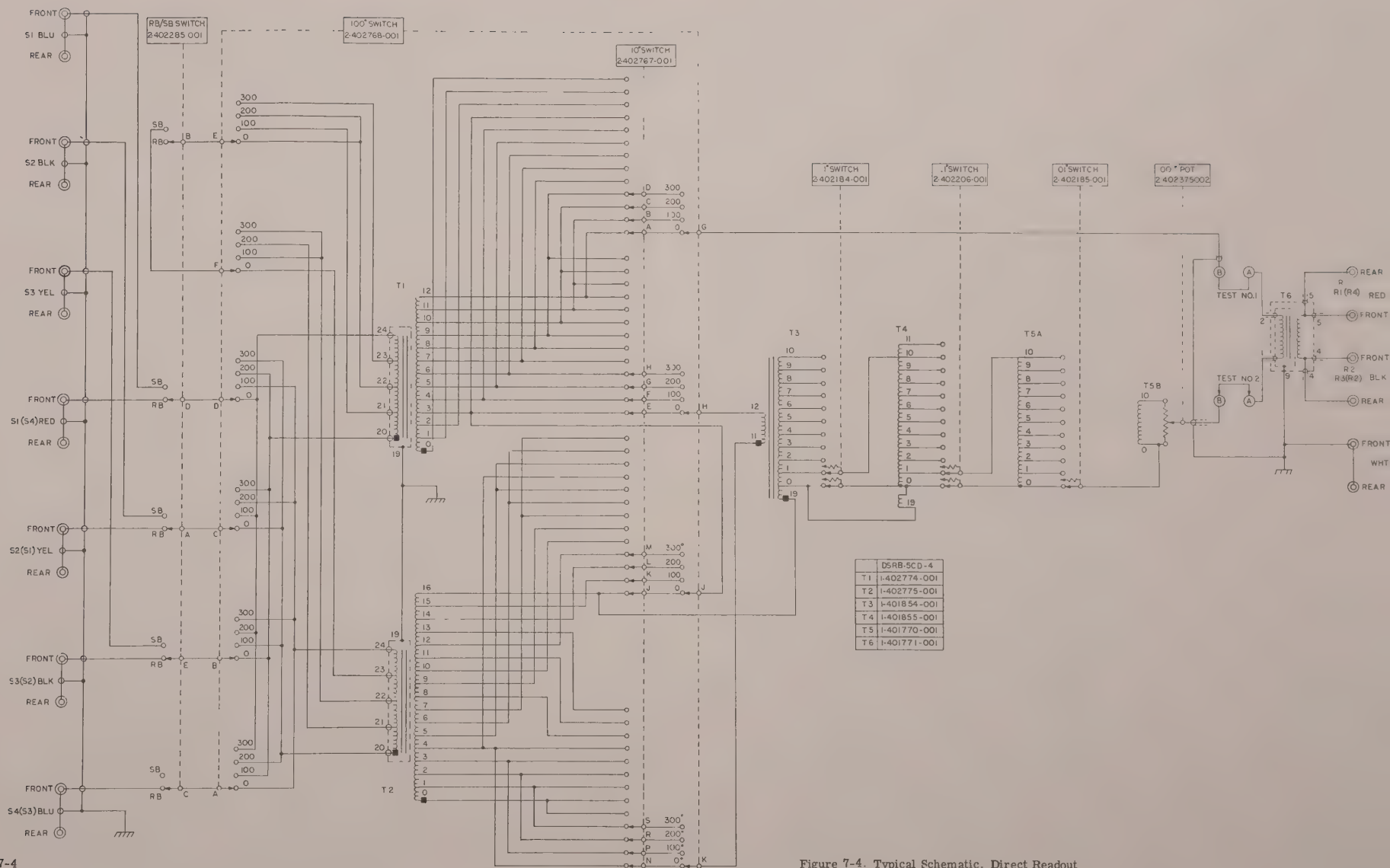


Figure 7-4. Typical Schematic, Direct Readout

SECTION VIII

PARTS LIST

(DECADE INCREMENTS)

ITEM	PART NO.	MFG	DSRB -5C-4, 8	DSRB -5CD-4, 8	DSRB -6CR	DSRB -6CDR
Binding Post, Red	29-3 RED	Grayhill	4	4	4	4
Binding Post, Black	29-3 BLK	Grayhill	6	6	6	4
Binding Post, Blue	29-3 BLU	Grayhill	4	4	4	2
Binding Post, Yellow	29-3 YEL	Grayhill	4	4	4	2
Binding Post, White	29-3 WHT	Grayhill	2	2	2	2
Binding Post, Green	29-3 GRN	Grayhill	4	4	4	4
Link Shorting, Test No. 1 and No. 2	AS310	Gertsch	2	2	2	2
Switch, 100°	2-402768-001	Gertsch		1		1
Switch, 90°	SW286	Gertsch	1		1	
Switch, 10°	SW203	Gertsch	1		1	
Switch, 10°	2-402767-001	Gertsch		1		1
Switch, 1°	SW184	Gertsch	1	1	1	1
Resistor, composition 1K ± 10%, 1/2W			4	4	4	4
Switch, .1°	SW206	Gertsch	1	1	1	1
Resistor, composition 47 ohms ± 10%, 1/2W			4	4	4	4
Potentiometer, 5 ohms ± 10%, 1W	RV5-1	Gertsch	1	1	1	1
Switch, mode	SW285	Gertsch	1	1	1	1
Knob	OP1	Gertsch	6	6	6	6
Transformer Assembly	TA517	Gertsch	1		1	
Transformer Assembly	TA566	Gertsch			1	
Transformer Assembly	1-002610-001	Gertsch		1		1

SECTION VIII
PARTS LIST
(OLDER MODELS)

ITEM	PART NO.	MFG	DSRB-3C-4	DSRB-3C-8	DSRB-4CR
Binding Post, Red	29-3 RED	Grayhill	4	4	4
Binding Post, Black	29-3 BLK	Grayhill	4	4	4
Binding Post, Blue	29-3 BLU	Grayhill	2	2	2
Binding Post, Yellow	29-3 YEL	Grayhill	2	2	2
Binding Post, White	29-3 WHT	Grayhill	2	2	2
Binding Post, Green	29-3 GRN	Grayhill	4	4	4
Link, Shorting, Test No. 1 and No. 2	AS310	Gertsch	2	2	2
Switch, 10°	AA1038-6	Gertsch			
Switch, 90°	SW286	Gertsch	1	1	1
Dial Assembly, 90° quadrants		Gertsch	1	1	1
Switch, 10°	SW203	Gertsch	1	1	1
Switch, 1°	SW334	Gertsch			
Switch, 1°	SW184	Gertsch	1	1	1
Resistor, composition 1K ±10%, 1/2W			4	4	4
Switch, .1°	SW334	Gertsch			
Switch, .1°	SW206	Gertsch	1	1	1
Resistor, composition 47 ohms ± 10%, 1/2W			4	4	4
Switch, .01°	SW184	Gertsch			
Switch, .01°	SW185	Gertsch	1	1	1
Resistor, composition 47 ohms ±10%, 1/2W			4	4	4
Switch, .001°	SW184	Gertsch			
Switch, .001°	SW185	Gertsch	1	1	1
Resistor, composition 47 ohms ±10%, 1/2W			4	4	4
Potentiometer, .001°, 5 ohms ±10%, 1W	RV5-1	Gertsch			
Dial Assembly, 1 to 10		Gertsch	5	5	5
Switch, mode	SW285	Gertsch	1	1	1
Knob	AC74	Gertsch			
Knob	OP1	Gertsch	6	6	6
Transformer Assembly	TA517	Gertsch	1	1	1
Connector, J1	XMRE75PF2016	Winchester			
Transformer Assembly	TA566	Gertsch			1

SECTION VIII
PARTS LIST

(DEGREES, MINUTES, SECONDS)

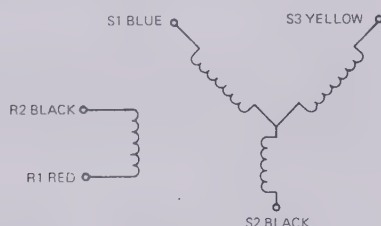
ITEM	PART NO.	MFG	DSRB-7C-4	DSRB-7C-8	DSRB-8CR
Binding Post, Red	29-3 RED	Grayhill	4	4	4
Binding Post, Black.	29-3 BLK	Grayhill	4	4	4
Binding Post, Blue	29-3 BLU	Grayhill	2	2	2
Binding Post, Yellow	29-3 YEL	Grayhill	2	2	2
Binding Post, White	29-3 WHT	Grayhill	2	2	2
Binding Post, Green	29-3 GRN	Grayhill	4	4	4
Link, Shorting, Test No. 1 and No. 2	AS310	Gertsch	2	2	2
Switch, 90° quadrants	SW286	Gertsch	1	1	1
Dial Assembly, 90° quadrants		Gertsch	1	1	1
Switch, 10°	SW203	Gertsch	1	1	1
Switch, 1°	SW184	Gertsch	1	1	1
Resistor, composition, 1K $\pm$ 10%, 1/2W			4	4	4
Switch, 10'	SW293	Gertsch	1	1	1
Resistor, composition, 47 ohms $\pm$ 10%, 1/2W			4	4	4
Switch, 10''	SW335	Gertsch	1	1	1
Resistor, composition 47 ohms $\pm$ 10%, 1/2W			4	4	4
Switch 1' and 1''	SW185	Gertsch	2	2	2
Resistor, composition, 47 ohms $\pm$ 10%, 1/2W			4	4	4
Dial Assembly, 1 to 10		Gertsch	6	6	6
Switch, mode	SW285	Gertsch	1	1	1
Knob	OP1	Gertsch	6	6	6
Transformer Assembly	TA564	Gertsch	1	1	

Synchro and Resolver Testing

Component Description

Synchros and resolvers transmit mechanical angular data via electrical means. The angular position is converted to an electrical signal by a control transmitter. The electrical signal is transmitted to a receiver which then converts the electrical signal to a mechanical position. The mechanical position determines the amplitude of the output signal or signals and thus synchros and resolvers may be viewed as variable transformers.

SYNCHRO CONTROL TRANSMITTER (CX). In a synchro control transmitter, the system reference voltage is applied across a single rotor winding which functions as a primary. Three stator windings (secondaries) are displaced 120 degrees from each other and are star connected.



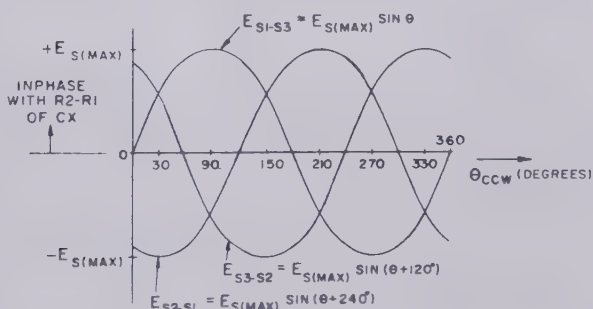
The induced voltage in each stator winding is either in-phase or 180 degrees out-of-phase with the input voltage. The magnitude of the voltage depends upon the rotor position relative to that specific winding. The output voltages relative to the input vary according to the following formula:

$$E_{S1-S3} = N E_{R2-R1} \sin \theta$$

$$E_{S3-S2} = N E_{R2-R1} \sin (\theta + 120 \text{ degrees})$$

$$E_{S2-S1} = N E_{R2-R1} \sin (\theta + 240 \text{ degrees})$$

where N is the transformation ratio and θ is positive for CCW rotation from electrical zero (EZ) as viewed from the shaft end.



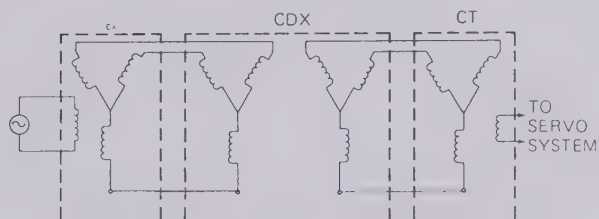
$$E_s (\text{max}) = N E_{R2-R1}$$

Standard Synchro Control Transmitter (CX) Outputs as a Function of CCW Rotation From Electrical Zero (EZ).

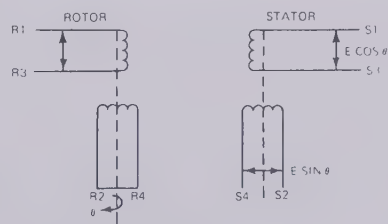
These three voltages completely and uniquely define an angular position and this data is normally supplied to a control transmitter (CT) or a control differential transmitter (CDX).

CONTROL TRANSFORMER (CT). In a control transformer, the three stator windings function as the primary and the single rotor winding functions as the secondary. When the angular positions of the rotor and the electrical signal are the same, the output of the rotor winding is a null voltage. Any difference in angular position produces a voltage output which, in turn, is used to drive a servo system.

CONTROL DIFFERENTIAL TRANSMITTER (CDX). A control differential transmitter includes three rotor and three stator windings. It is used to modify a three-wire signal from a control transmitter. The three-wire output corresponds to the sum or difference of the input angle and the mechanical angle of the rotor.



RESOLVER CONTROL TRANSMITTER (RX). Resolvers normally include two stator and two rotor windings. In a resolver control transmitter, the reference voltage is applied to one of the stator windings which functions as the primary. The secondaries produce two separate voltages: one voltage is proportional to the sine of the rotational angle and the second is proportional to the cosine.



RESOLVER CONTROL TRANSFORMER (RC). In an RC, the stator windings function as the primary and one of the rotor windings functions as the secondary. When the angular positions of the rotor and the electrical signal are the same, the output is a null voltage. Any difference in angular position produces a voltage output which, in turn, drives a servo system.

RESOLVER DIFFERENTIAL TRANSMITTER (RDX). An RDX includes two rotor and two stator windings. It is used to modify the two separate voltage signals from a resolver control transmitter (RX). The two voltage outputs correspond to the sum or difference of the input angle and the mechanical angle of the rotor.

Component Testing

Test	Angular Accuracy	Null Voltage	Transformation Ratio	Phase Shift
CX	DH, PAV, SB	DH, PAV	DH, PAV, RT	DH, PAV
CDX	DH, PAV, SB, SS	DH, PAV	DH, PAV, RT	DH, PAV
CT	DH, PAV, SS	DH, PAV	DH, PAV, RT	DH, PAV
RX	DH, PAV, RB	DH, PAV	DH, PAV, RT	DH, PAV
RD	DH, PAV, RB, RS	DH, PAV	DH, PAV, RT	DH, PAV
RC	DH, PAV, RS	DH, PAV	DH, PAV, RT	DH, PAV

DH - Dividing Head

PAV - Phase Angle Voltmeter

RT - Ratio Transformer

SS - Synchro Standard

SB - Synchro Bridge

RS - Resolver Standard

RB - Resolver Bridge

NOTE: Also see Engineering Bulletins No. 1, 2, 3, and 4.

Angular Accuracy

The angular accuracy of a data-transmission synchro or resolver is briefly defined as the difference between the mechanical and the electrical position. The difference is referred to as the electrical error and is expressed in angular units.

The DH is the precision angular positioning device used to mechanically rotate a unit under test. An SB, an SS, an RS or an RB, is used to measure the electrical position of the unit under test. All components may be tested at 5 degree increments throughout the 0 to 360 degree range. When the dividing head and the bridge or standard are set to the same angular position, the output of the test setup should be a null voltage. Any voltage output indicates electrical error and, in the test method used, the amount of voltage output is directly related to angular error (proportional voltage gradient method). The fine zero control of the DH provides the means for introducing an exact angular error. With the test setup set to null, the DH may be offset by the maximum allowable angular error. This will produce a maximum allowable error voltage which is applied to the PAV. The variable range control of the PAV may be adjusted to provide full scale deflection on the voltmeter. Less than full scale deflection may be calculated as a percentage of the maximum allowable angular error.

Null Voltage

Null voltage is the voltage component of the minimum output signal. Fundamental null voltage is synonymous with quadrature voltage since the in-phase output voltage at this point is zero.

A 0 degree excitation voltage is applied to the primary of the unit under test and the PAV is connected across the secondary. The unit under test is adjusted to produce an in-phase null voltage and then the fundamental and total null voltages are measured with the PAV.

With the PAV set to the TOTAL function, the PAV indicates the total null voltage including harmonics and noise. With the PAV set to the FUND function, a band-pass filter is switched into the circuit to eliminate noise and harmonics. The PAV therefore indicates the fundamental component of the selected frequency.

Transformation Ratio

Transformation ratio (N) is the ratio of the fundamental component of the no-load secondary voltage to the fundamental voltage applied to the primary. The ratio is measured at the first position of maximum coupling in the positive direction (CCW as viewed from the shaft end) from electrical zero. For these tests, the excitation voltage is applied across the primary of the unit under test and across an RT. The PAV is connected between the high side of the secondary and the arm of the RT and functions as a phase sensitive null indicator. The RT is adjusted until a null is indicated. The output to input ratio of the unit under test may then be read from the setting of the ratio controls. The ratio controls indicate the ratio of the fundamental components only at 90 degrees. Since there may be phase shift through the unit under test, the ratio is divided by the cosine of the phase shift angle (ϕ) to obtain the total transformation ratio.

Phase Shift

Phase shift (ϕ) is the difference between the time phase of the fundamental component of the primary and secondary voltages. Phase shift is measured at the first position of maximum coupling in the positive direction from electrical zero (EZ).

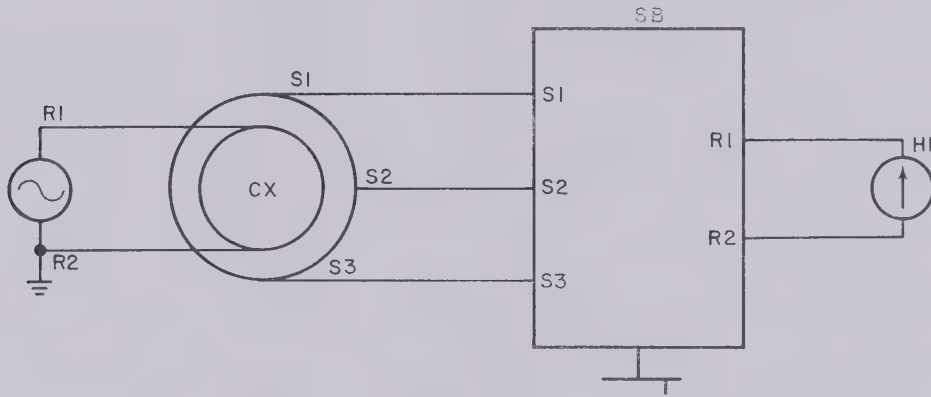
For this test, the PAV is used as a phase angle measuring device. The excitation voltage is applied across the primary and the PAV is connected across the secondary. The unit under test is rotated to the first position of maximum coupling and the PAV is adjusted to measure phase angle.

The phase sensitive detector of the PAV indicates a peak deflection when the instrument is set to the exact phase shift angle and a null when the instrument is set 90 degrees from the exact phase shift angle. Since null indications are more precise than peak deflections, the PAV is adjusted to measure the quadrature null. In reading ϕ , the 90 degree setting of the PAV FUNCTION switch is ignored and ϕ is read directly from the setting of the DEGREES dial.

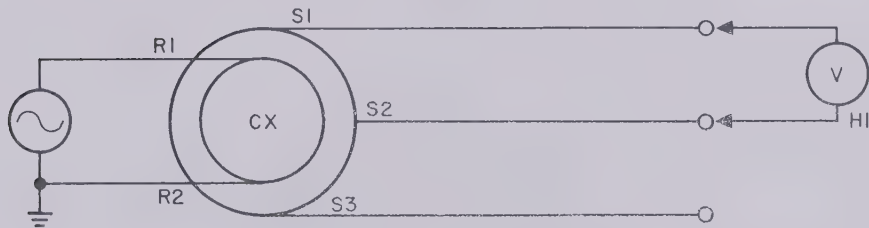
Synchro Control Transmitter (CX) Tests

The electrical output of the control transmitter (S1, S2, S3) is applied to a synchro bridge (SB). The synchro bridge is a precision transformer instrument which produces an error voltage (across R1 and R2) when its angular position differs from the equivalent angular position of the three-wire signal applied to the input.

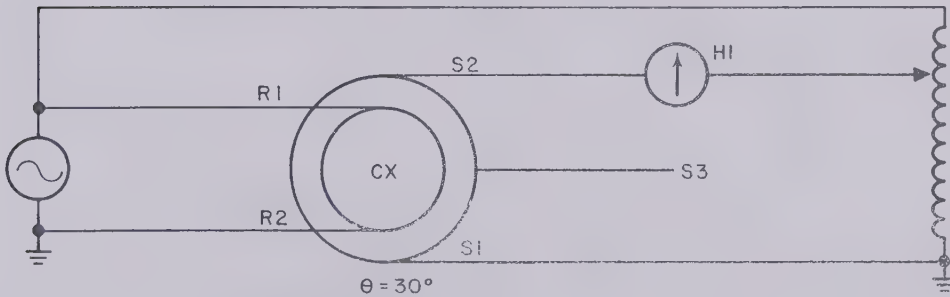
The error voltage is directly related to the angular difference but is not constant throughout the 0 to 360 degree range of the bridge. To provide an equal error voltage (voltage gradient) at all increments, a scaling transformer is included as the compensating network. With the addition of the compensating network, the electrical error may be determined without the necessity of obtaining an exact null.



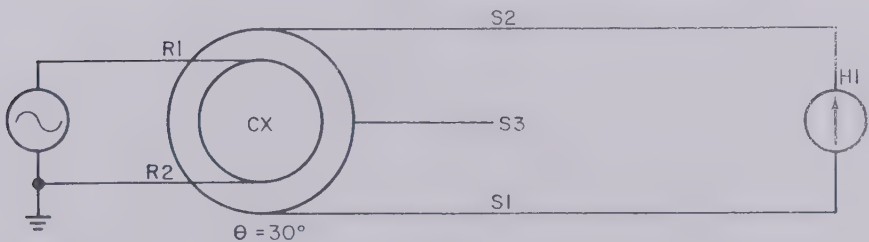
Control Transmitter (CX) Angular Accuracy Test Circuit (AA)



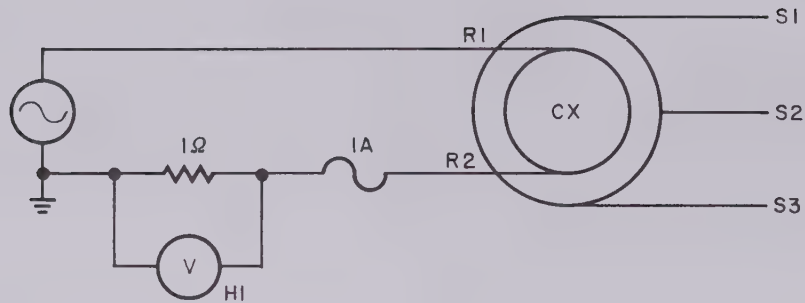
Control Transmitter (CX) Null Voltage Test Circuit



Control Transmitter (CX) Transformation Ratio Test Circuit (N)



Control Transmitter (CX) Phase Shift Test Circuit (ϕ)



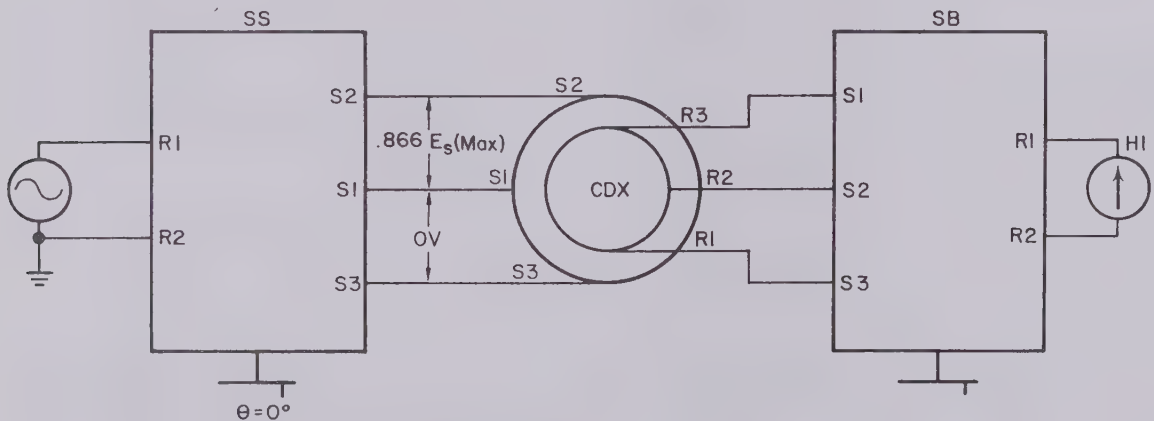
Control Transmitter (CX) Input Current Test Circuit (I_p)

Synchro Control Differential Transformer (CDX) Tests

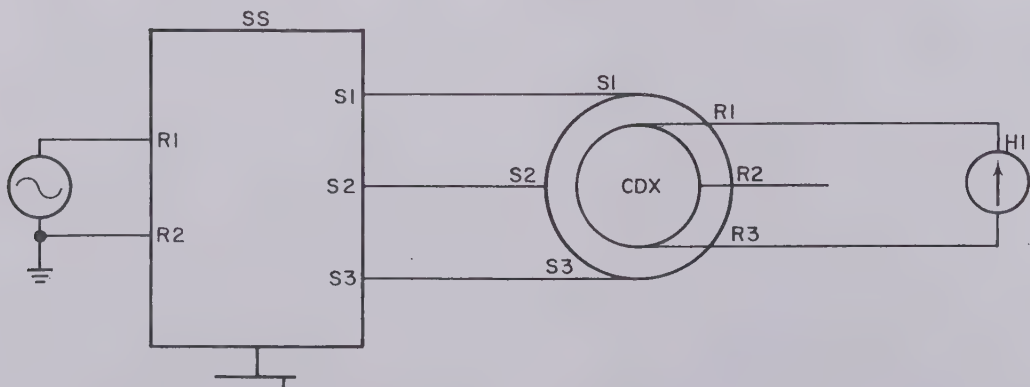
ROTOR TESTS. The two wire excitation voltage is converted to a three wire signal in a synchro standard (SS). The three wire output of the SS is applied to the stator (S1, S2, S3) of the CDX and functions as the 0 degree reference voltage. The electrical output of the CDX (R1, R2, R3) is applied to a synchro bridge (SB). For this test, the SS is set to 0 degrees for all tests and the DH and SB are rotated.

The synchro standards is a precision transformer instrument which simulates the ideal outputs of a synchro control transmitter (CX). The SS produces three output voltages "120 degrees in amplitude" from each other. One of the three voltages is directly related to the sine of the angle displayed by the unit.

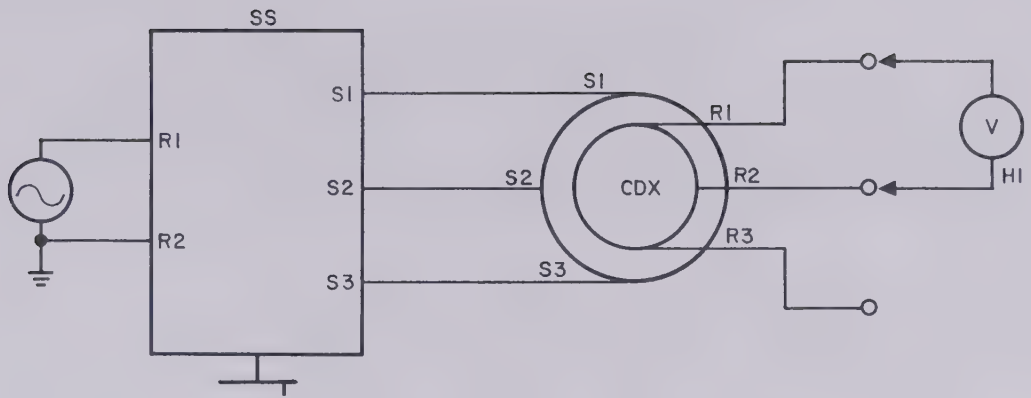
STATOR TESTS. As with the rotor tests, the two wire excitation is converted to a three wire signal in the SS and applied to the stator (S1, S2, S3). For this test, the SS and the DH are rotated and the error voltage is measured across the rotor (R1, R3).



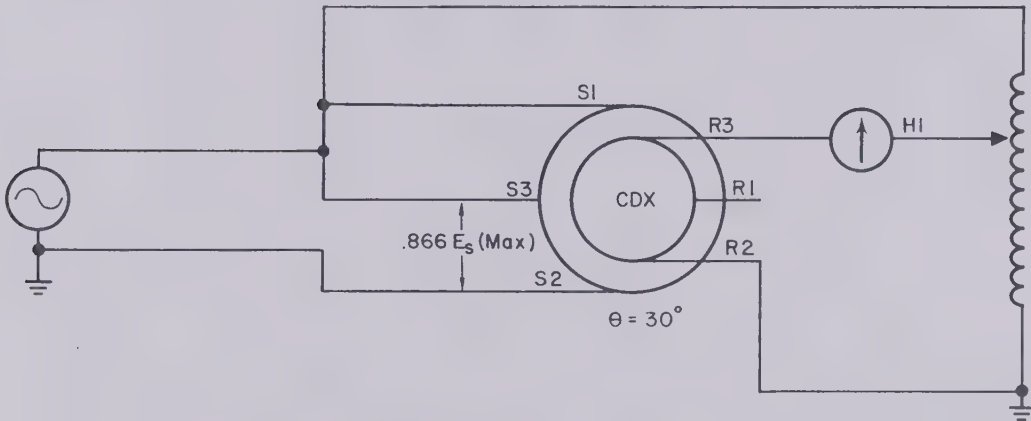
Control Differential Transformer (CDX) Rotor Angular Accuracy Test Circuit (AA)



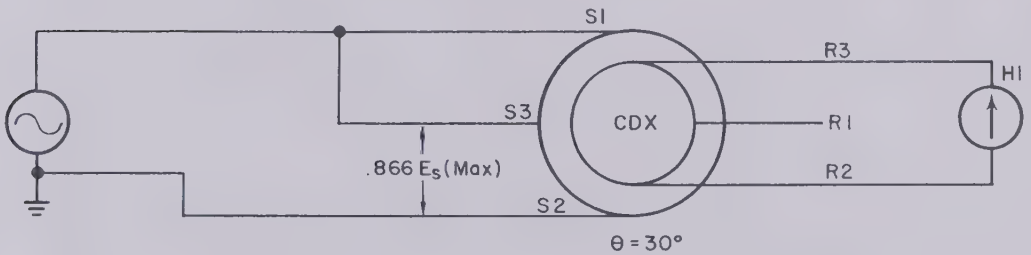
Control Differential Transformer (CDX) Stator Angular Accuracy Test Circuit (AA)



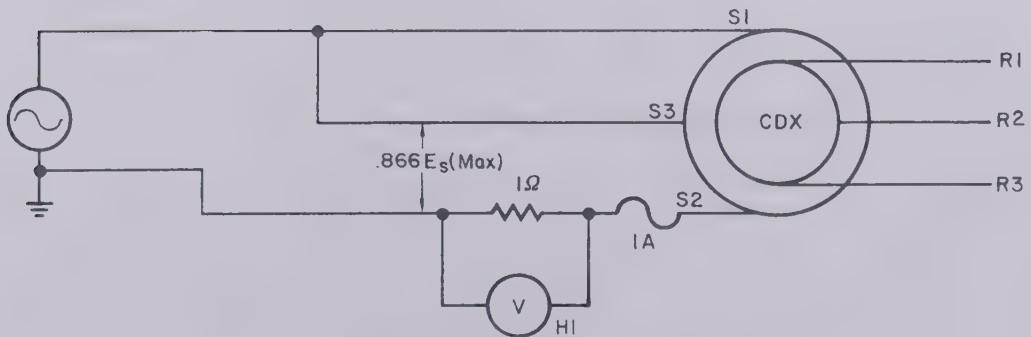
Control Differential Transformer (CDX) Null Voltage Test Circuit



Control Differential Transformer (CDX) Transformation Ratio Test Circuit (N)



Control Differential Transformer (CDX) Phase Shift Test Circuit (ϕ)

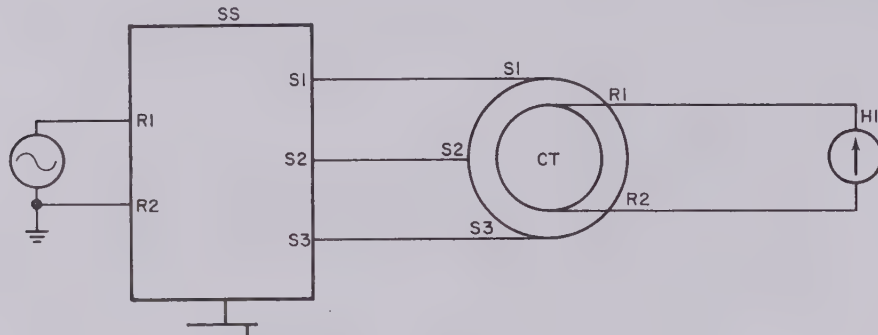


Control Differential Transformer (CDX) Input Current Test Circuit (I_p)

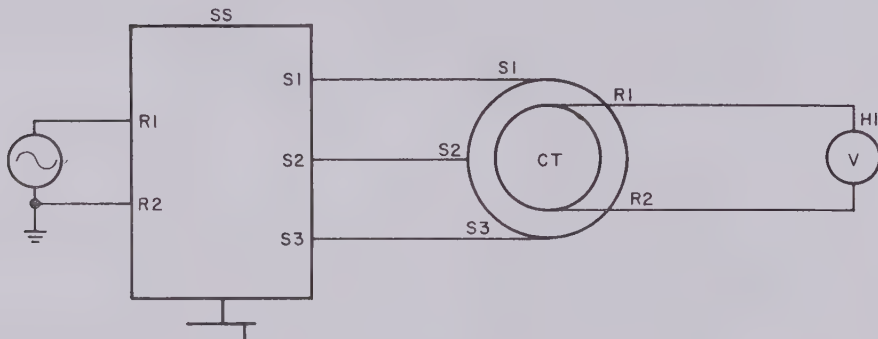
Synchro Control Transformer (CT) Tests

The two wire excitation voltage is converted to a three wire signal in a synchro standard (SS). The three wire output of the SS is applied to the stator (S1, S2, S3) of the CT. The SS and the DH are rotated and the error voltage is measured across the rotor (R1, R2).

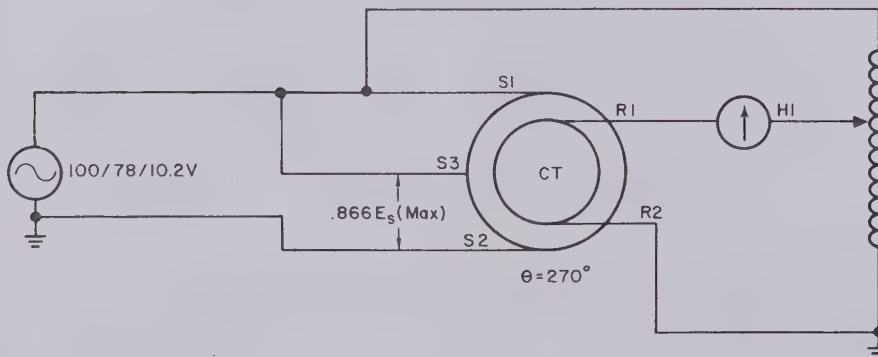
The synchro standard is a precision transformer instrument which simulates the ideal outputs of a synchro control transmitter (CX).



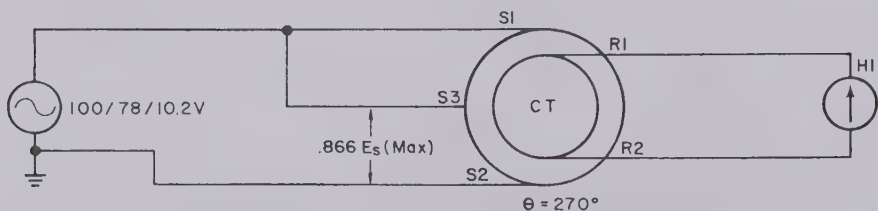
Control Transformer (CT) Angular Accuracy Test Circuit (AA)



Control Transformer (CT) Null Voltage Test Circuit



Control Transformer (CT) Transformation Ratio Test Circuit (N)



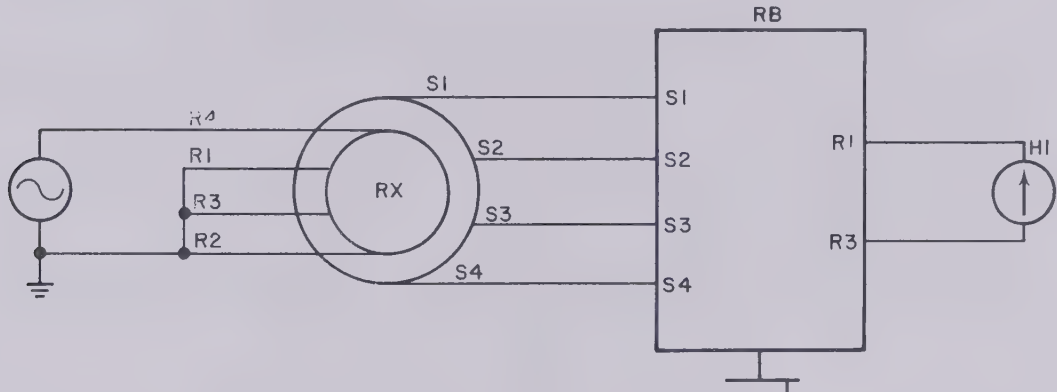
Control Transformer (CT) Phase Shift Test Circuit (ϕ)

Control Transmitter (RX) Tests

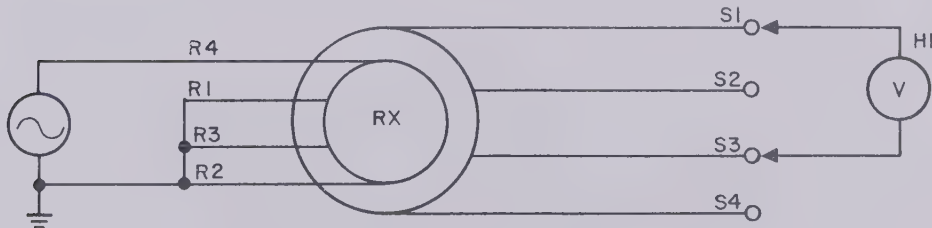
The two wire excitation voltage is applied to the rotor (R2, R4) of the unit under test. The unit produces two signals which are applied to a resolver bridge (RB),

The resolver bridge uses precision transformers to form a voltage comparator bridge. The two voltage signals into the bridge bear a precise voltage ratio relationship which is determined by the angular position of the unit under test. Each signal is applied across a ratio transformer and movement of the ratio transformer arms is equivalent to change in the angular position of a control transformer. When the equivalent angular positions of the bridge and the input signals are identical, the output of the bridge (R1, R3) is null.

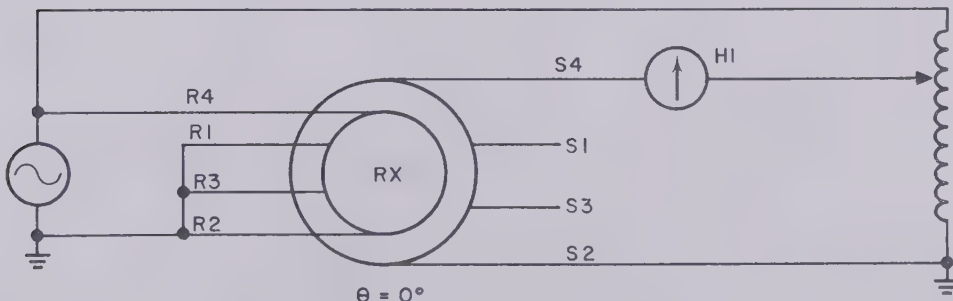
When the equivalent angular positions of the bridge and the input signals differ, the bridge produces an error voltage. This error voltage is directly related to the angular difference, but is not constant at each increment. To provide an equal error voltage gradient at all increments, the bridges are inherently compensated. With compensation, the electrical error of a component under test may be determined without the necessity of obtaining an exact null at each increment (proportional voltage gradient method).



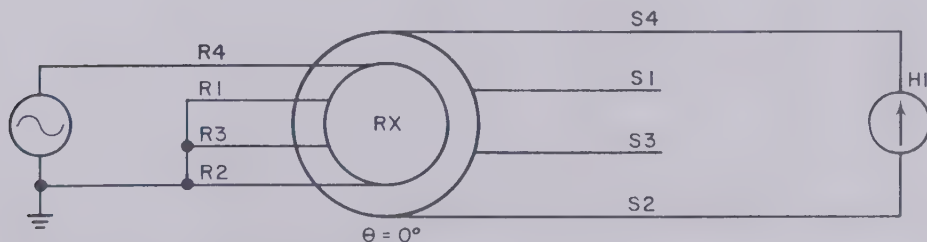
Control Transmitter (RX) Angular Accuracy Test Circuit (AA)



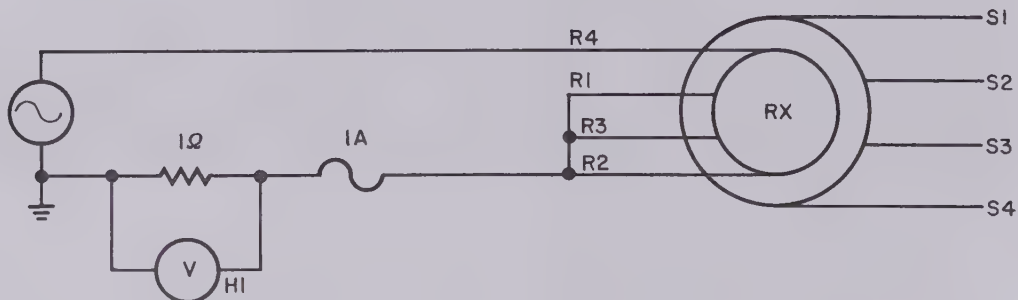
Control Transmitter (RX) Null Test Circuit



Control Transmitter (RX) Transformation Ratio Test Circuit (N)



Control Transmitter (RX) Phase Shift Test Circuit (ϕ)



Control Transmitter (RX) Input Current Test Circuit (Ip)

Control Differential Transmitter (RD) Tests

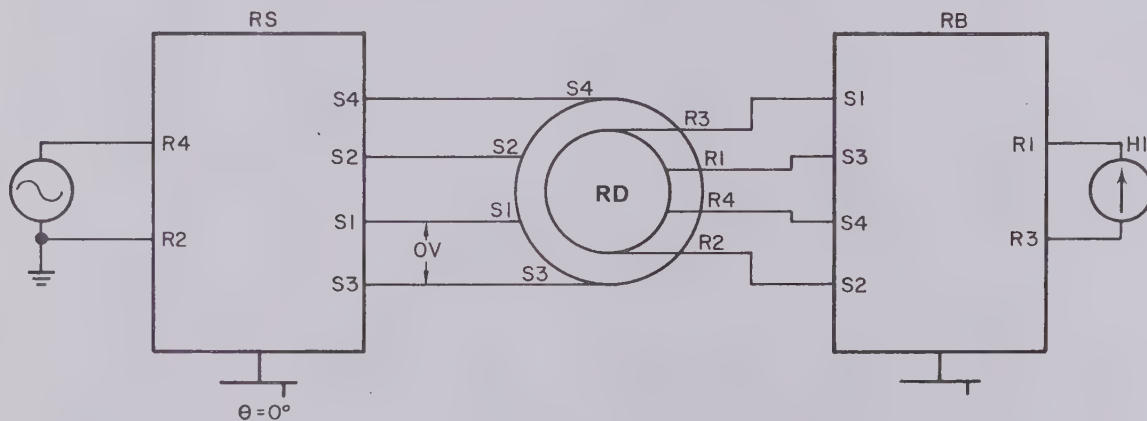
ROTOR TESTS. The two wire excitation voltage is converted to two separate (four wire) signals in a resolver standard (RS). The four wire output of the RS is applied to the stator (S1, S2, S3, S4) of the RD and functions as the 0 degree reference voltage. The electrical output of the RD (R1, R2, R3, R4) is applied to a resolver bridge. For this test, the RS is set to 0 degrees for all tests and the DH and RB are rotated.

The resolver standard is a precision transformer instrument which simulates the ideal outputs of a resolver control transmitter (RX). The RS produces two output voltages, one of which is related to the sine of the angle displayed on the unit and the other is related to the cosine.

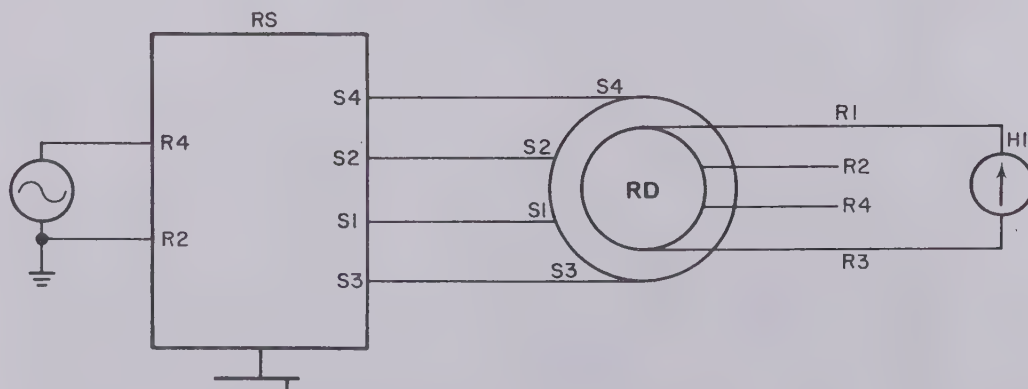
STATOR TESTS. As with the rotor tests, the two wire excitation voltage is converted to two separate signals in the RS and applied to the stator of the RD. For this test, the RS and the DH are related and the error voltage is measured across the rotor (R1, R3).

Control Transformer (RC) Tests

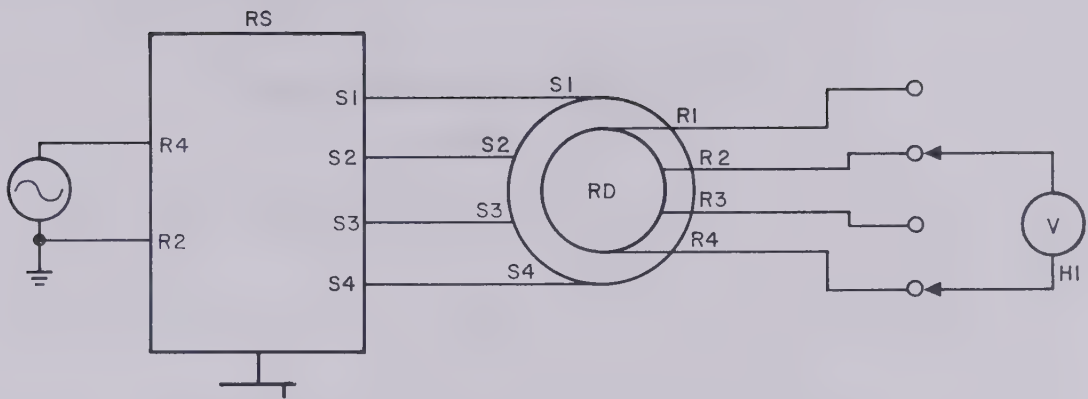
The transformer tests are similar to the stator tests of an RD.



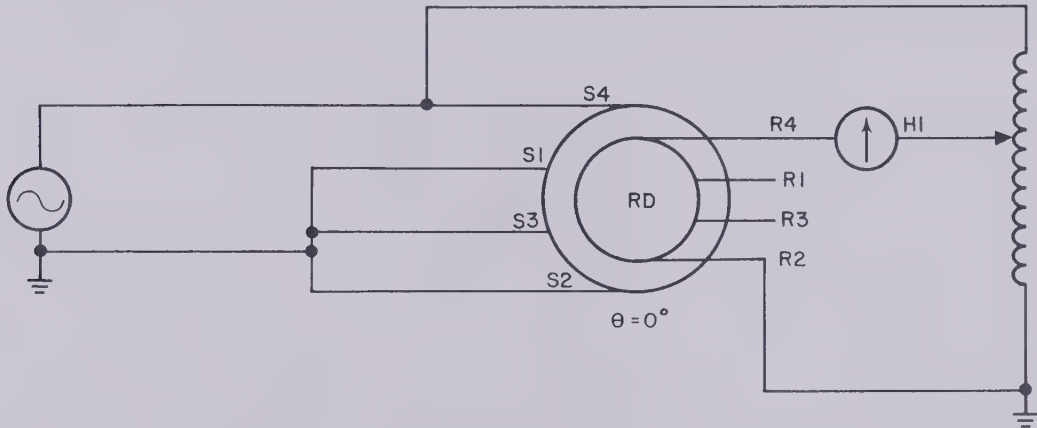
Control Differential Transmitter (RD) Rotor Angular Accuracy Test Circuit (AA)



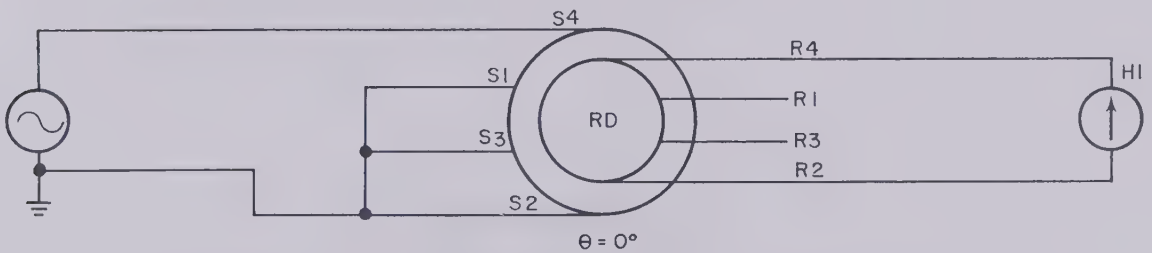
Control Differential Transmitter (RD) Stator and Transformer (RC) Angular Accuracy Test Circuit (AA)



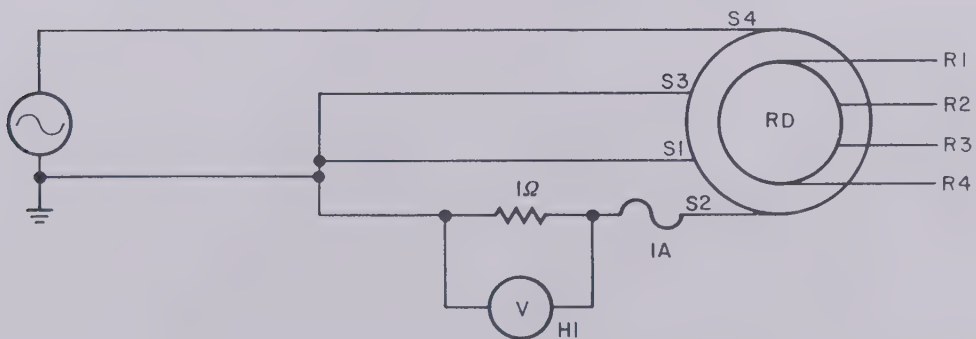
Control Differential Transmitter (RD) and Transformer (RC) Null Test Circuit



Control Differential Transmitter (RD) and Transformer (RC) Transformation Ratio Test Circuit (N)



Control Differential Transmitter (RD) and Transformer (RC) Phase Shift Test Circuit (ϕ)



Control Differential Transmitter (RD) and Transformer (RC) Input Current Test Circuit (I_p)

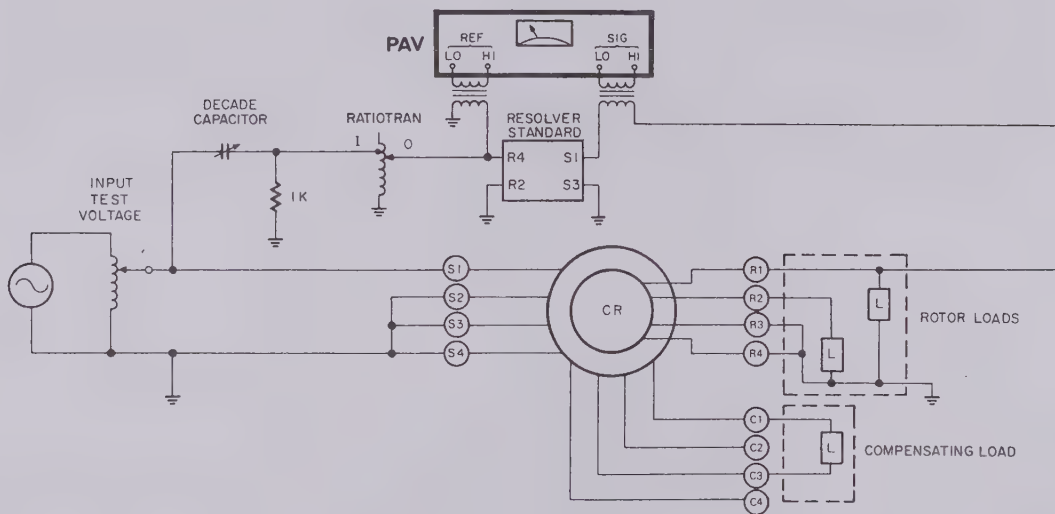
Computational Resolver Tests

Functional Accuracy

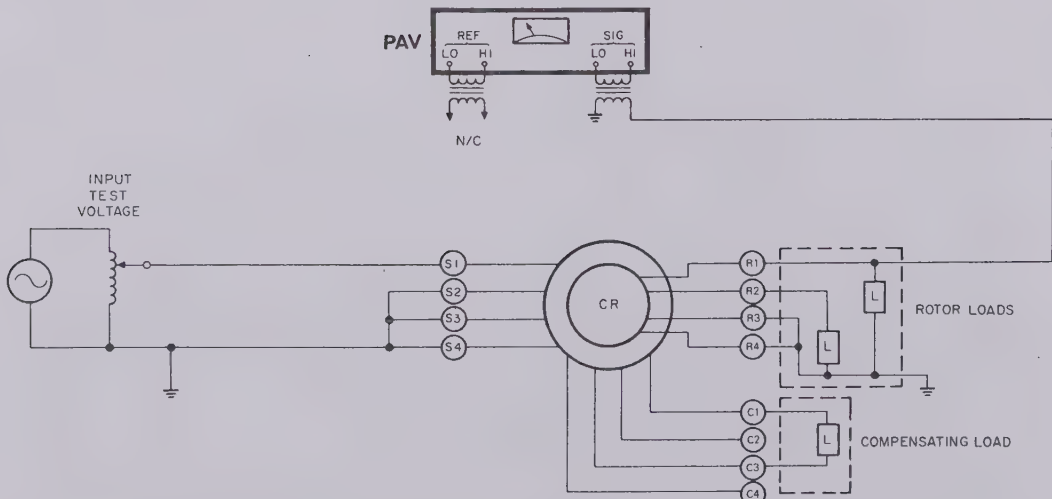
Functional accuracy is a measure of the accuracy with which a computational resolver computes a trigonometric equation. This accuracy is generally expressed as a percentage of the output at the point of maximum coupling. The output of a .1% computational resolver is maximum at 90 degrees for the sine function. The accuracy is therefore .001 times the voltage ($E_s \text{ MAX}$) at 90 degrees ($\sin \theta = 90 \text{ degrees}$).

A dividing head is the precision angular positioning device used to mechanically rotate a unit under test. A resolver standard produces a $\sin \theta$ reference voltage to measure the computed output of the unit under test. All components may be tested at 5 degree increments throughout the 0 to 360 degree range.

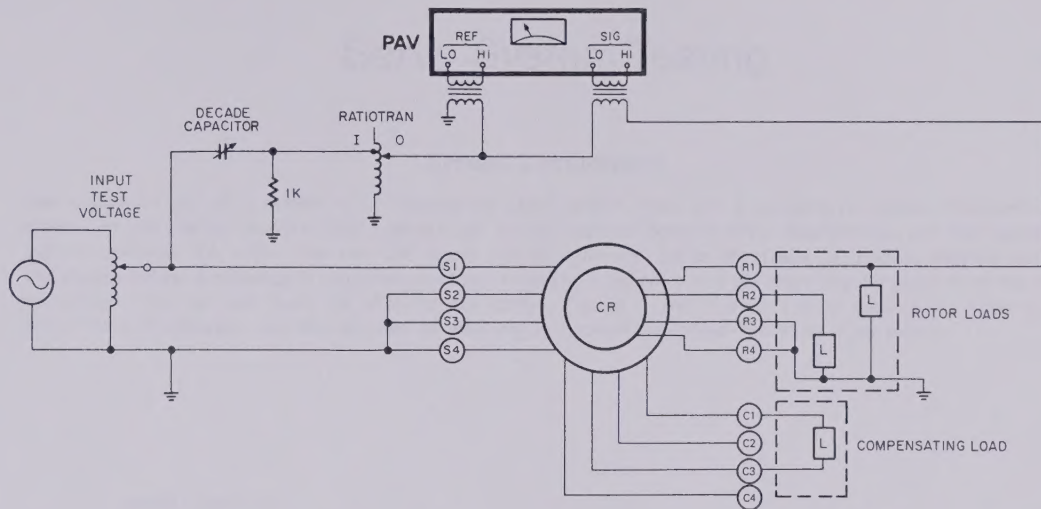
The decade capacitor and the 1K resistor are used to compensate for any phase shift through the unit under test. These components are used to shift the phase of the reference input to the phase angle voltmeter and the resolver standard. The RatioTran by the same process compensates for any variation in transformation ratio through the unit under test.



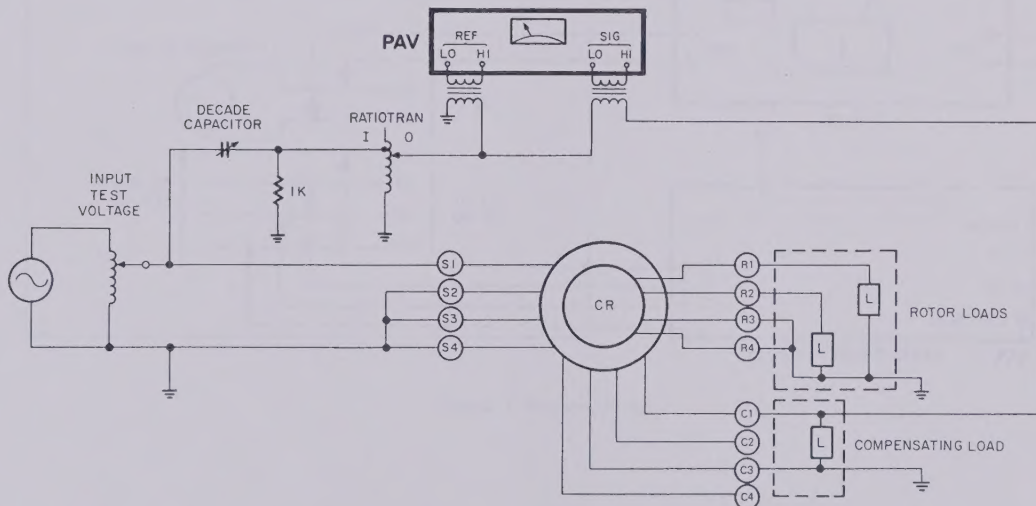
Functional Accuracy Test (S1-S3/R1-R3)



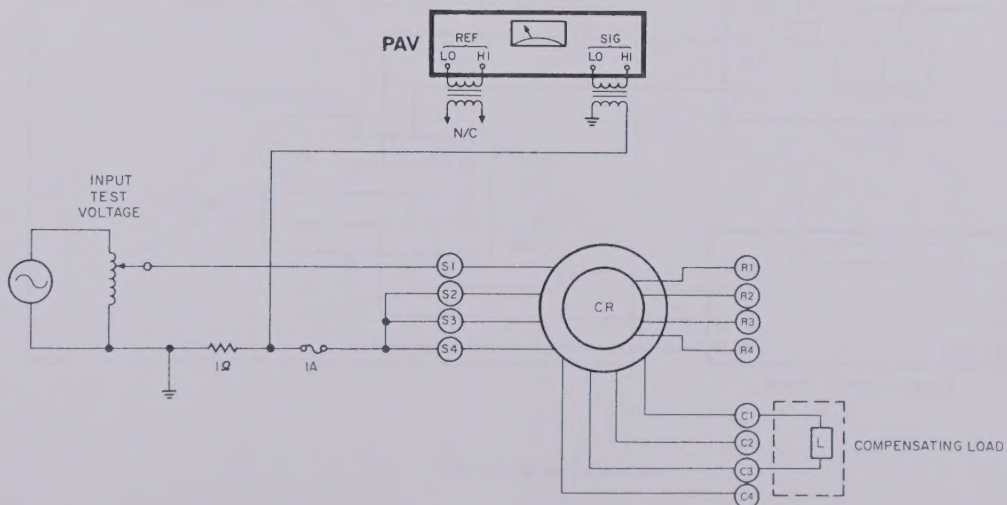
Null Voltage Test (S1-S3/R1-R3)



Stator to Rotor Transformation Ratio and Phase Shift Test (S1-S3/R1-R3)



Stator to Compensator Transformation Ratio and Phase Shift Test (S1-S3/C1-C3)



Input Current Test (S1-S3)

Generating Exact System Inputs

Gertsch bridges or standards may be used in a number of ways to generate an exact system input. Standards may be installed in a system as a master component as shown in figures 3 through 6.

Bridges may be used in two ways: (1) to set a system component to an exact position or (2) installed in a system as a master component as shown in figures 7 and 8. The bridge may be used to set a component to an exact position with the methods shown in figures 1 and 2.

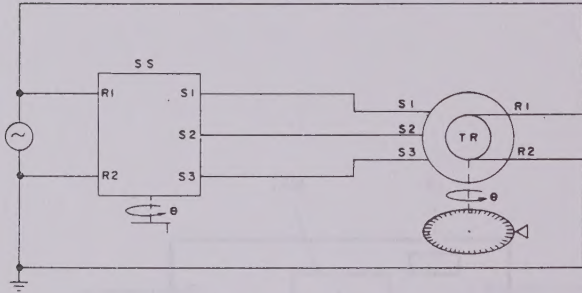


Figure 3. Using an SS as a "Dummy Director" to Position a Torque Receiver (Repeater)

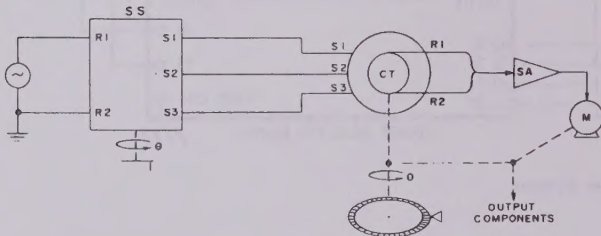


Figure 4. Using an SS as a "Dummy Director" to Position a Single-Speed Servo

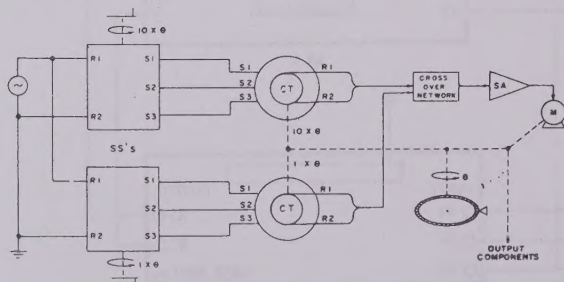


Figure 5. Using Two SS's as a "Dummy Director" to Position a Two-Speed Servo**

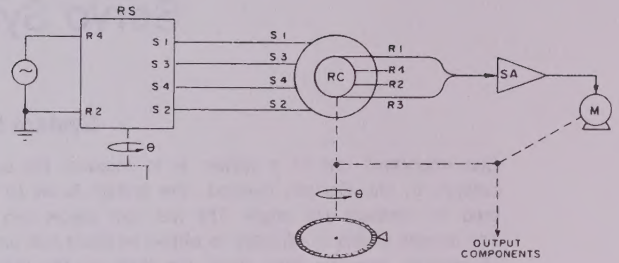


Figure 6. Using an RS as a "Dummy Director" to Position a Single-Speed Servo.

Measuring System Response

These same techniques may be used to measure drift or stability of components through full rotation. Either the PAV or the NI-5 may be calibrated to read angular deviation directly in minutes or seconds. The bridge or standard is off-set by the maximum allowable error. This will produce a maximum allowable error voltage which is applied to the PAV or the NI-5. The range controls of these instruments may be adjusted to provide full scale deflection on the meter. Less than full scale deflection may be calculated as a percentage of the maximum allowable system error.

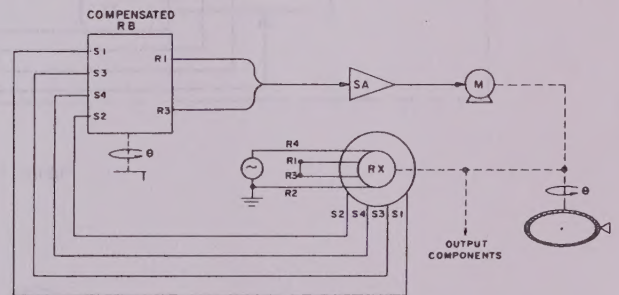


Figure 7. Using an RB to Position a Single-Speed Servo

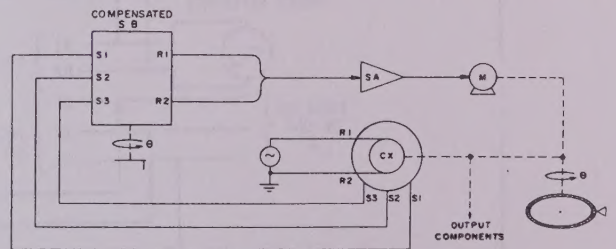


Figure 8. Using an SB to Position a Single-Speed Servo

